COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

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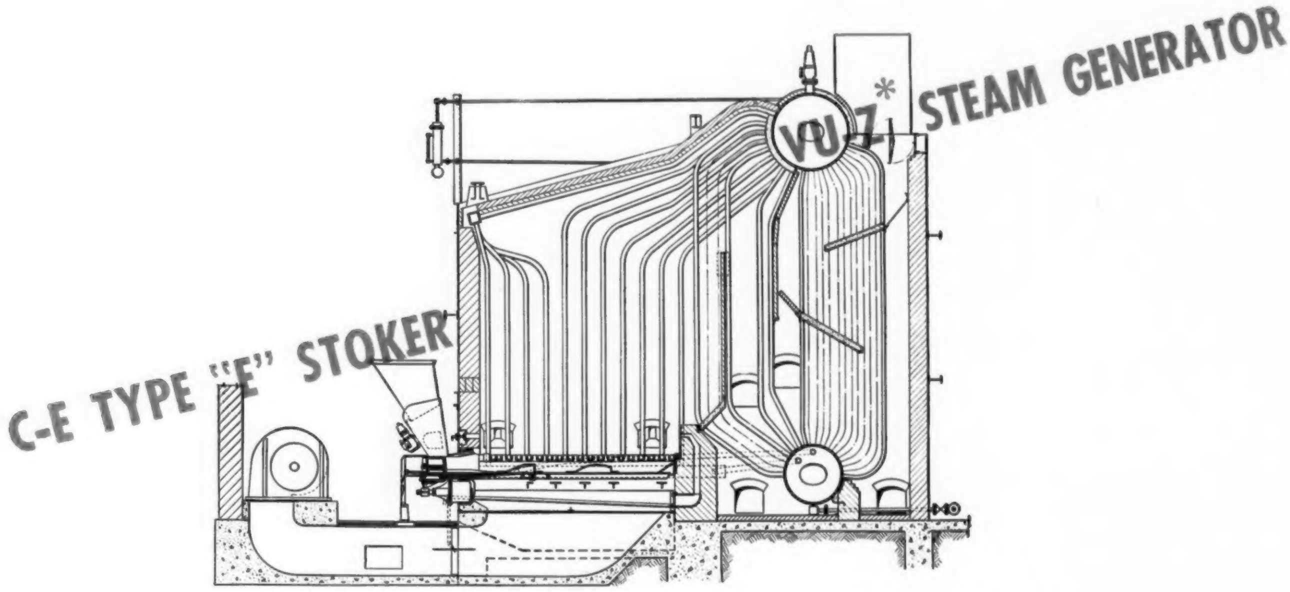
Discussions at A.S.M.E. Annual Meeting ▶

1825-Lb Pressure Topping Unit ▶

Combustion Control for Spreader Stokers ▶

With any type of stoker firing You can have the advantages of VU STEAM GENERATOR DESIGN

EXAMPLE NO. 2



For a wide variety of bituminous coals and for capacities ranging up to 50,000 lb of steam per hr, the Type VU-Z Steam Generator and the Type E Stoker make an excellent combination.

Inherent in the VU-Z design are all the basic features and "performance-proved" advantages of Combustion Engineering's well-known VU Unit, with adaptation of the furnace design to the requirements of stoker firing. And the Type E Stoker brings to the combination the kind of performance that can be expected from a product widely regarded as the leader in its field with installations aggregating well over 4000, of which nearly 40 per cent are repeat orders.

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** The VU-Z Steam Generator provides the advantages of Combustion Engineering's well-known VU Unit with a furnace and arrangement of heating surface especially adapted for stoker firing.*

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200 Madison Avenue New York, New York

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

VOLUME FOURTEEN NUMBER SIX

CONTENTS

FOR DECEMBER 1942

FEATURE ARTICLES

EDITORIALS

DEPARTMENTS

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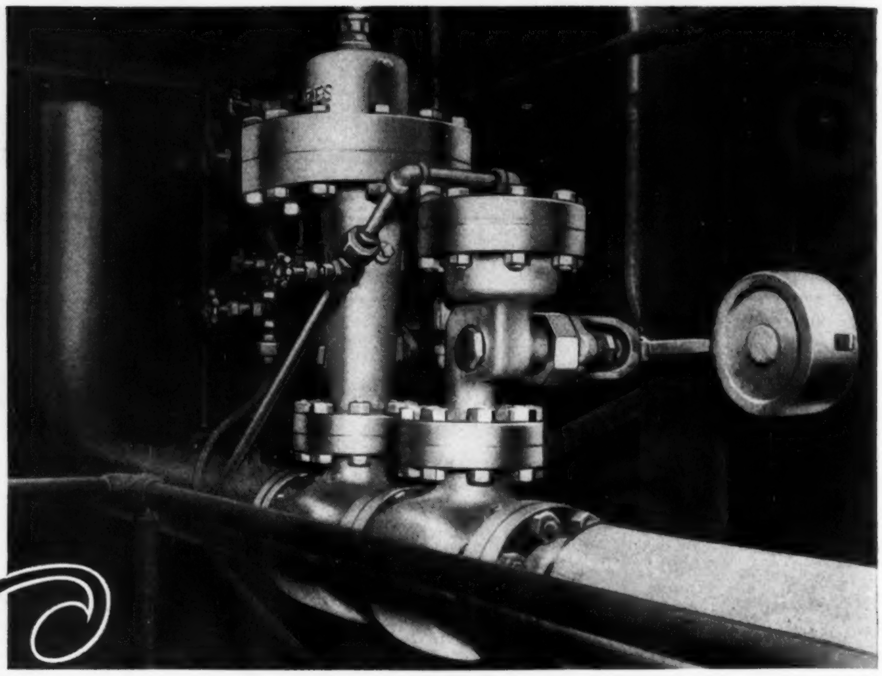

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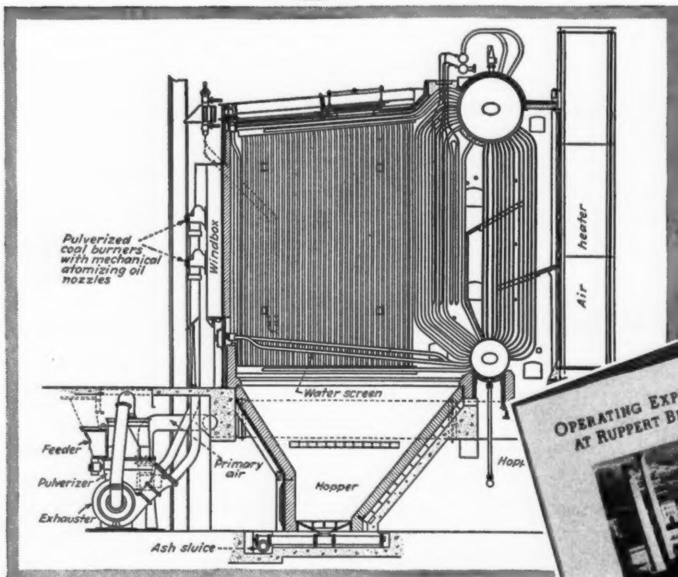
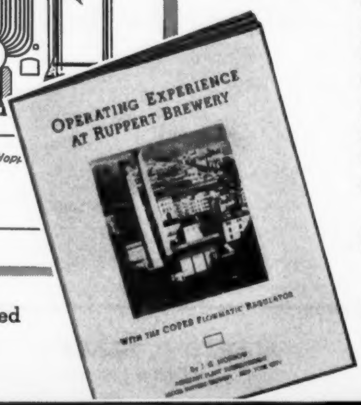


Combustion Engineering Type VU Boiler as installed at Jacob Ruppert Brewery, New York City.



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EDITORIAL

Stokers in the Lead

The present year is destined to eclipse records of recent years in the number of industrial stokers sold, due in large measure to conversions brought about by the oil situation and in part to many new war plants. Indications point to a continuance of this trend in months ahead.

One may be led to speculate as to the permanency of this swing and to what extent there may be a reversion to oil after the cessation of hostilities. Although it would be presumptuous and futile at this time to attempt to forecast what the post-war situation may be, it is of interest to review certain factors that are likely to have bearing on it.

In the first place, our merchant marine will be very much larger than heretofore and for a considerable time at least will be engaged in re-establishing trade, in supplying the forces to be maintained abroad and in replenishing devastated countries, even though many ships may ultimately be tied up, as was the case following the last war. Also peace-time naval demands are certain to be greater. These combined should create a sustained demand for fuel oil afloat.

A re-established automobile industry and greatly increased air travel and transport should step up the gasoline requirements, and delayed private building construction will create a large demand for heating oil.

Assuming that the synthetic rubber program results in a satisfactory product, it is likely that our post-war commercial rubber requirements will be supplied largely from this source, rather than from imported natural rubber. This would mean a further new market for petroleum, although the extent of such a market is debatable at present.

On the other hand, the Government, profiting from experience and imbued with a desire to exercise greater economic control over natural resources than in the past, may adopt a more stringent oil conservation program.

In the domestic heating field, widespread re-conversions to oil are to be anticipated as soon as an adequate supply becomes available, chiefly because of the element of convenience. However, in the industrial power plant field, the situation is likely to be somewhat different. Admittedly, stokers involve higher initial investment and somewhat greater skill in operation than oil firing —factors which in the past may have influenced selection in some cases; but with conversion having already necessitated this investment and the operators having in the meantime become proficient in stoker firing, it is reasonable to assume that it would take a considerable differential in fuel price to bring about re-conversions to oil in many such cases.

The extent to which the foregoing considerations may affect future fuel oil prices is at present anyone's guess. However, it will be recalled that during the last two or three decades, there have been recurring cycles of oil and coal firing in certain sections of the country, due principally to transitory competitive fuel markets. That such cycles may be repeated is probable, despite such factors as now appear indicative of post-war trends.

CMP to Replace PRP for Certain Materials

A Controlled Materials Plan, as affecting carbon steel and alloy steel, copper, aluminum, and certain other materials, is being inaugurated by the War Production Board and will become effective in the second quarter of 1943 to replace the Production Requirements Plan now in use. Obviously, an abrupt transition from one system to the other would bring about some confusion, hence this period will be one of readjustment, with the new plan prevailing as universally as possible after July first.

With this system bills of material and estimated requirements, by months, for war production will be submitted and tabulated; and the quantities of steel, copper and aluminum available will be apportioned among the various projects by the Requirements Committee of WPB.

Experiences with the Production Requirements Plan appear to have confirmed the misgivings of many who had seen its shortcomings during the last year, and the new plan, as applied to these strategic materials, seems a more logical approach to the problem. In fact, it differs little from that practiced by Germany during the years she was preparing for the present conflict, and in certain respects is similar to the British warrant system which appears to have worked satisfactorily.

The CMP, as the new plan is designated, will concern many suppliers of power plant equipment; and after it has begun to function smoothly, it is anticipated that completion of many jobs will be expedited, in contrast with delays encountered under the present system through non-delivery of some important link in a plant's makeup. In other words, under the new plan it should be possible better to synchronize equipment deliveries within the availability of the materials involved.

Nevertheless, the process of changing over from one established system to another equally intricate system in the midst of unprecedented production activity is certain to cause many headaches. For some weeks past the War Production Board has been engaged in training its personnel in the operation of the new plan, and, through talks by its key men before groups representing producers, has endeavored to disseminate information on the procedure. The transition period will be helpful.

Some Discussions at the A.S.M.E. ANNUAL MEETING

THE numerous sessions at the 1942 Annual Meeting of the American Society of Mechanical Engineers held at the Hotel Astor, New York, November 30 to December 4, included several Panel Discussions, or Symposiums, and papers dealing with problems that intimately and currently concern designers and operators of steam power plants. The former included sessions on "Boiler Water Problems," "Feedwater Heating Cycles" and "Tube Expanding"; and among the papers in this category were two on "Embrittlement of Boiler Steel," one on "Spreader Stoker Firing," "Centrifugal Pump Performance" and "Tests on Steam Pipe Insulation." These are covered in the following report, and another important paper dealing with the design and performance of a high-pressure forced-circulation boiler is abstracted separately because of its length.

The holding of Panel Discussions was carried out more generally this year than heretofore and extended also to fields other than power. The large attendance and comprehensive discussion at each attested to the usefulness of this forum-type of program in bringing out helpful ideas and experiences pertinent to the problems at hand.

Tube Expanding

A session on Monday evening was given over to the subject of rolling in and expanding tubes in boilers, heat exchangers and condensers. Three coordinated papers were presented dealing respectively with (1) theoretical analysis of the problem; (2) the results of experimental investigations and (3) practical applications.

The first paper, by **Prof. J. N. Goodier** of Cornell University and **G. J. Schoesson** of Babcock & Wilcox Company, on "The Holding Power and Hydraulic Tightness of Expanded Tube Joints," represented a theoretical analysis of stress and deformation based on the theory of plasticity. Calculations were restricted to radial and circumferential stresses and curves plotted showed the variation of residual pressure with thickness of tube, plate thickness and hardness. This pressure between the tube and seat, which gives it tightness and contributes to its strength, was the principal object of the calculations. The theoretical values arrived at, although slightly lower, were in general agreement with the test data reported in the companion paper.

The second paper, by **Prof. G. H. Lee** of Cornell University and **E. W. Grimison** of Babcock & Wilcox Company, gave the results of an experimental investigation to determine the fundamentals involved in tube expanding, the methods of measuring the degree of expansion, the optimum degree of expanding and the ultimate strengths of expanded joints under various conditions of service.

All tubing used in the investigation was $3^1/_4$ in. OD by 0.17-, 0.32- and 0.50-in. wall thickness, which was expanded into seat disks $1^1/_2$ in. thick, using three-roll propulsive expanders with the belling rolls removed. All seats were plain, no grooves being employed. The seats were bored to $3^9/_{32}$ in., giving a nominal clearance of $^1/_{32}$ in. on the diameter and the tubes were buffed free of rust and scale.

The following conclusions were drawn from the data obtained:

1. A characteristic variation in seat pressure on the tube with degree of expansion was found. The seat pressure rises rapidly with increase in the degree of expanding to a sharply peaked maximum, then falls off equally rapidly to a limiting value which is nearly constant.

2. Seat pressure increases with thickness of tube but is not related to it by a simple law of proportionality. Increase in relative hardness of either seat or tube increases the radial pressure within limits which appear to be at about 150 Bhn for the seat plate. Beyond this hardness there is no appreciable increase in seat pressure. From the standpoint of ease of expanding and damage to the plate, a soft tube in a hard seat is much to be preferred to the opposite condition.

3. A sharply peaked maximum in seat pressure appears to be due to restraining extrusion of the tube. It does not follow that any particular type of grooving will produce the required restraint.

4. Within the limits of a comparatively few tests, structural strengths of expanded joints have been determined and were given in the paper. Repeated loading tests to 1000 cycles and to 70 per cent of the ultimate load resulted in no reduction of ultimate strength in either torsion or bending.

Practical Considerations

In the third paper in which **C. A. Maxwell,** of Babcock & Wilcox Company, dealt with "Practical Aspects of Making Expanded Joints," the author recalled that as long as pressures were low and did not involve thick plates, tube seats were formed simply by drilling a plain hole in the plate into which the tube was inserted and expanded. But as pressures increased, plates became thicker and the seats wider. This has greatly complicated the expanded tube joint as used in most high-pressure vessels, and other forces, due to structural design and temperature differentials during operation, act on the joint cumulatively with those produced by hydrostatic pressure.

Reference was made to unpublished results of an investigation made some years ago by A. W. Lienau which indicated that with a standard roller expander optimum holding-power values were obtained when the seat width was between $1^1/_4$ and $1^1/_2$ in. Any width beyond these values contributed nothing to the holding power and, in many cases, actually reduced resistance to leakage. In view of this, it had been the practice of Mr. Maxwell's company, up until a couple of years ago, to countersink the holes and utilize only this optimum seat width.

It was also found that the axial movement of the tube within its seat could be used advantageously if grooves were machined in the seat, as slight extrusion of the tube against the edges of the grooves formed a seal against leakage. Two grooves about $^3/_{32}$ in. wide and $^1/_{32}$ in. deep, separated on $^7/_{16}$-in. centers, and located in the center of the seat, gave the best all-round results. Two grooves separated by a land were superior to a wide groove, because the intervening land backed up the tube during the expanding operation. The plain tube seat, from $1^1/_4$ to $1^1/_2$ in. wide, into which a tube is properly expanded, can be made and maintained hydrostatically tight for any commercial pressure only so long as the forces operating on the joint are due wholly to pressure within the vessel.

The author then told of a new expander, employed by his company during the last two years and adapted to wide tube seats, in which rolling is accomplished in steps, beginning at the middle opposite the grooves, with uniform pressure exerted over the circumference of the tube. The employment of steps is said to reduce the temperature differentials and temperature stresses set up in the usual rolling procedure. The tube is cleaned to reduce friction and a water-soluble lubricant employed. With this method all extrusion is radial, within the limits of the seat width, and there is no endwise extrusion of the metal. A three-roll expander was advocated.

In the discussion following Mr. Maxwell's paper the extensometer method of controlling tube rolling was defended and its advantages stressed. Also, the five-roller expander had its adherents.

Boiler Water Problems

A Panel Discussion on "Boiler Water Problems" was held on Wednesday morning under the auspices of the Power Division and the Joint Research Committee on Boiler Feedwater Studies. The agenda included (1) a review of the general problems encountered in high-temperature, high-pressure operation; (2) boiler water scales, particularly those due to the presence of silica; (3) carryover and (4) turbine deposits. The panel was arranged with twelve experts leading the discussion on these phases of the subject, supplemented by discussion from the floor; but it developed that the experts, representing the chemists' and operators' viewpoints, were not in full agreement on many points, hence, unanimity of opinion was lacking. However, the discussion which centered largely on silica deposits, was productive of certain indications, if not conclusions.

With reference to scales, it was pointed out that calcium and magnesium scales, which are more likely to form at pressures below 400 lb, can be easily controlled; whereas silica is more likely to form at higher pressures and is difficult to remove. In order to cope effectively with the latter it is necessary to determine how it is formed in the boiler water but, so far, relatively little information is available, particularly as to how much silica can be present without troublesome scale forming. One speaker expressed the opinion that silica tends to deposit out of the boiler water at the point where the water is converted into steam. The ratio of alkalinity to silica was believed to be important.

A case was mentioned, that of a large central station in which the low-pressure boilers were cleaned once a year despite condenser leakage and makeup accounting for 6 ppm silica. In the same station the high-pressure boilers, which now have large makeup because of steam used in district heating, employ zeolite treatment and the small quantity of baked sludge that is formed contains some silica but it presents no serious problem in removal.

Disagreement among some of the experts centered around the possibility of copper deposits being responsible for pitting and corrosion.

Theories of Carryover Discussed

As to the subject of carryover, the mechanical, evaporation, solubility, caustic and molten-salt theories were reviewed. Neither the caustic nor the molten-salt theories account for silica deposits, but that of solubility can apply. It was suggested that since different salts have different solubilities this may explain the selective deposits on turbine blades, although sufficient evidence is lacking to support this contention.

The nature of the carryover appeared to be more important than the amount, and both pure silica and sodium silicate, when present, are usually found in the low-pressure stages of the turbine.

Another discusser cited a 1400-lb central station in which silica deposits are formed on the turbine blading, despite an indicated steam purity of $^1/_4$ ppm. In this case the scale in the high-pressure stages is of such a character as to be removable by washing with wet steam, but in the low-pressure stages sandblasting becomes necessary. In the boilers, silica scale is found at the bottom of the tubes.

It was conceded that carryover depends on a number of factors, including boiler design and operating practice

Silica deposits on turbine blades appear in two forms—silvery gray crystals on high-pressure blading and a glassy deposit on low-pressure blading. The crystals may occur alone or in combination with sodium oxide. The deposits are usually found on the convex surfaces of the blades, except where the gray crystals occur by themselves and these may be found also on internal surfaces other than the blades. The explanation advanced for the formation on the convex surfaces was the fall in pressure. It was pointed out that 1 ppm of solids in the steam to a large turbine may amount to as much as $2^1/_2$ tons per year.

Mention was made of a comprehensive survey lately undertaken by the Prime Movers Committee of the E.E.I. to determine, by means of questionnaires mailed to member companies, the water treatment employed, experience with deposits, operating conditions and many other data. Through a compilation and study of the replies, it is hoped to arrive at some definite conclusions.

In contrast with the foregoing discussion, one engineer, who represented a large company operating a number of central stations in widely separated localities, some employing pressures of 900 lb, told of their practice of not employing any feedwater treatment or deaerators, despite which no carryover or troublesome scale is encountered. The evaporators are blown down periodically and care is exercised to have the condensers tight.

Prevention of Embrittlement Cracking

At last year's Annual Meeting, it will be recalled, there were a group of papers reporting field tests with the embrittlement detector developed by W. C. Schroeder and his associates at the Bureau of Mines Eastern Experiment Station, in connection with its program of embrittlement studies. These papers related results with various inhibitors.

This year, at one session on "Boiler Feedwater Studies," two papers on this subject were presented: one on "A Practical Way to Prevent Embrittlement Cracking," by **A. A. Berk** and **W. C. Schroeder** of the Bureau of Mines, and the other on "Boiler Embrittlement" by **Carl A. Zapffe** of Battelle Memorial Institute. The former represented the conclusion of the program initiated about ten years ago by the Joint Research Committee on Boiler Feedwater Studies.

Messrs. Berk and Schroeder gave a summary of more than 900 plant experiences with the embrittlement detector on operating boilers with variously treated boiler waters. The principal inhibitors employed were sodium nitrate, quebracho extract, waste sulphite liquor and zero-caustic alkalinity. Included were a considerable number of specimens tested under conditions where no known inhibitor was present in sufficient quantity in the boiler water and in 40 per cent of these no cracking resulted. This indicated that additional unknown inhibitors may have been present or that, in some cases, the absence of cracking may have been due to improper operation of the apparatus.

Sodium Nitrate

The tabulation showed that 117 specimens were not cracked when the boiler water contained relatively high concentrations of sodium nitrate, the nitrate having, in many cases, been added to waters that had previously produced cracking. These data showed that boiler water containing a minimum ratio of sodium nitrate to total alkalinity of 0.3 did not cause embrittlement cracking of detector specimens.

Sodium nitrate is an inexpensive chemical and is easily handled and controlled. It is thermally stable and has not adversely affected boiler operation in the range from 125 to 400 psi. However, its usefulness has not yet been determined at pressures above 400 psi, as compared with 700 psi for quebracho and 800 psi for the treatment that produces zero-caustic alkalinity. In alkaline boiler water it is apparently inert to sodium sulphite and the other salts usually present.

Quebracho Extract

Results obtained with quebracho extract were almost as satisfactory as those with sodium nitrate. Only five specimens, out of 114, were cracked when a quebracho-total alkalinity ratio of 0.4 was maintained, and these may have been due to improper procedures. Quebracho extract is a tannin obtained from South American trees and relatively crude extracts have been found superior to processed spray- or self-dried products.

Waste Sulphite Liquor

These liquors are by-products of the wood-cellulose industries, the active ingredients being lignin-sulphonate compounds. While these have been used with apparent success in a large number of locomotive boilers, they cannot be recommended at present for stationary boilers because of reported foaming difficulties.

Zero-Caustic Alkalinity

Since caustic is primarily responsible for embrittlement, its elimination in the boiler water provides a means of controlling cracking. While some alkalinity is desirable to prevent corrosion, it makes no difference whether the hydroxide ions are furnished by caustic soda or by some other chemical, such as trisodium phosphate, which reacts to release hydroxide ions. Trisodium phosphate neither causes nor prevents cracking but it is a substitute for caustic soda as the source of alkalinity in the boiler water. By reducing the concentration of caustic to approximately zero, the need for an inhibitor is eliminated. When so used, the method is best controlled upon the basis of the relationship of pH to PO_4 concentration.

Although only eight specimens have thus far been tested, in the operating range from 300 to 800 psi, with this treatment to eliminate caustic alkalinity, none has cracked. These were run on boilers using evaporated makeup, for which the method is said to be especially suited.

Hydrogen Embrittlement

Doctor Zapffe's paper represented the metallurgist's approach to the subject and was based largely on investigations carried on at Battelle dealing with hydrogen embrittlement of steel. In such action, the hydrogen precipitates in the slip planes of the metal, attacks nonmetallic ingredients and forms gas pockets which exert tremendous pressures to separate grain boundaries and produce cracking. The action is transcrystalline at the lower temperatures and intercrystalline at higher temperatures, in both cases affecting the ductility.

Although the author expressed the opinion that the various investigations of boiler embrittlement had been predicated erroneously on the caustic rather than the hydrogen approach, the concensus of the discussion which followed was that such cracking of boiler metal always starts in contact with concentrated caustic solution and that hydrogen embrittlement applies to a range of higher temperatures than those encountered with boiler steam. Hence, it was believed to have very little bearing on the problem.

One discusser of the first paper was of the opinion that sodium nitrate was best suited to the average industrial plant because of its very much lesser cost and that the zero-caustic alkalinity method was better adapted to larger plants employing evaporated makeup. The discoloration of the boiler water with quebracho extract was advanced as a factor against its use.

Feedwater Heating Cycles

From the power engineer's standpoint, one of the most profitable sessions of the Annual Meeting was the Panel Discussion on Thursday afternoon dealing with "Feedwater Heating Cycles." This were arranged to explore the possibilities, advantages and limitations of more uniform steam-extraction practices on large condensing turbines operating on the regenerative cycle. The views of turbine and boiler manufacturers, plant designers and central station engineers were sought and frankly given, particularly with reference to the "Preferred Standards for Steam Turbine-Generators" as adopted in November 1938 by the National Defense Power Committee. These preferred standards are given in the table below.

Views of Turbine Manufacturers

Representatives of the turbine manufacturers were in agreement that it would be undesirable to adopt any arbitrary or mandatory standards as to turbine types, sizes or steam conditions such as might impede progress or be inapplicable to special cases, but it was felt that in the great majority of cases there is little necessity to deviate greatly from general practice and that savings in both time and expense could be effected by adopting a greater degree of uniformity in extraction openings in the turbine casing for a given frame size. In this connection, it was pointed out that much time is often lost between the placing of a contract with the turbine manufacturer and the issuing of the shop order for casing castings, due to delay in definitely determining the extraction scheme or heat balance. In some cases subsequent changes have caused further delays.

It was believed that if heat-balance schemes for the average case could be kept sufficiently uniform as to the requirements on the turbine so as to keep the extraction points more constant in location and size, much delay could be eliminated by the turbine manufacturer obtaining castings and forgings on stock manufacturing orders in anticipation of orders from customers. Although designs are now made as flexible as possible to accommodate different extraction points, unfavorable compromises are sometimes thereby involved.

With recognition of the fact that in many cases conditions in existing stations have to be met, it was shown that throttle pressure can be varied considerably without much change in extraction pressure. Furthermore, with extraction openings fixed, some latitude is possible in switching blade rings to vary the extraction pressure by as much as 5 or 10 per cent. Overall economy is relatively insensitive to final stage pressure and much of the variation occurs on the flat portion of the economy curve. Also, a small change in the percentages of steam taken by the several heaters usually accounts for variations in economy of from one-twentieth to one-tenth of one per cent.

The thought was expressed by one discusser that if turbines were to be provided with the maximum number of standardized extraction openings, extra costs and delays would not be incurred and those points not required in the particular case could be blanked off.

Effect of Feedwater Temperature on Design of Steam-Generating Units

The views expressed by three representatives of large boiler manufacturers were in general accord. It was pointed out that although the design of the entire steam generating unit is affected by feedwater temperature, to standardize this temperature for given steam conditions would accomplish little by itself, since there are so many other variable factors that must be taken into consideration. Among these are type and character of the fuel, method of firing, space limitations affecting furnace proportions, superheated steam temperature and range of load over which constant steam temperature is desired—all of which are interrelated and govern the proportioning of the unit.

But to illustrate the effect of feedwater temperature on the design of steam-generating units, two hypothetical cases, involving the same total evaporation and steam conditions, were cited—one with feedwater at 250 F and the other with 450 F feedwater. For the lower temperature the heat added by the unit per pound of steam generated is about 20 per cent greater than for the higher feedwater temperature. The quantity of fuel, the fuel preparation and burning equipment, the furnace and the gas flow, are all increased by about 20 per cent. Moreover, the superheater is affected because the gas flow is increased and the gas temperature drop would be decreased. These all affect the proportioning of the unit.

The economizer surface is affected by the water rise which depends on the entering feedwater temperature, whereas the heat absorption by the air heater depends upon the preheat temperature; that, in turn, may be dictated by the fuel or the type of fuel-burning equipment employed. A very high feedwater temperature usually indicates a large air heater in order to keep the stack temperature low, or if high preheat cannot be used, the economizer must be larger. Feedwater temperature also influences the superheat for given conditions.

Since both economizers and air heaters consist of a series of similar elements with details of construction largely standardized, the total surface of either is varied by varying the number of elements in width, height and length. Therefore, except for special conditions, the cost of engineering and time required in connection with this particular equipment would not be materially altered by changes in feedwater temperature.

NATIONAL DEFENSE POWER COMMITTEE
PREFERRED STANDARDS FOR CONDENSING STEAM-TURBINE GENERATORS

Item	General: All sizes—back pressure 1 in. or 1 1/2 in. Hg abs; Short Circuit ratio 0.9; Generator voltage 13,800; Excitation voltage 250					
Rating, kw	10,000	12,500	15,000	20,000	25,000	35,000
Rpm	3,600	3,600	3,600	3,600	3,600	3,600
Throttle pressure, lb/sq in. gage	650	650	650	850	850	850 or 1,250
Throttle temp, deg F	825	825	825	900	900	900
Number of extraction openings	3	3	3	3	3	4
Temp at extraction openings, ±10 deg F (at rated output)	170/225/290	170/225/290	170/225/290	170/225/290	170/225/220	170/225/290/350
Turbine capacity in per cent of kw rating	125	125	125	125	125	125
Power factor	0.8	0.8	0.8	0.8	0.8	0.8
Generator cooling (air or hydrogen)	Air	Air	Air	Air	Air or Hyd.	Hyd.

Although feedwater temperature affects furnace, superheater and boiler, other varying conditions make it impossible to standardize these components in most large high-pressure, high-temperature central station units. However, as one discusser pointed out, for industrial power units and some of the smaller central station units operating under 1000 lb pressure, where space conditions are favorable and specifications are not too rigid, it has been found possible to employ partially standardized units with consequent saving in time and engineering.

The designer of a steam generating unit generally is not in a position to select the conditions that would bring about some degree of standardization through which the customer would benefit by savings in cost and time. He designs to conditions very definitely specified by the purchasers' engineers. However, if it were possible to attain a greater degree of standardization in size of units, pressure, steam temperature, feedwater temperature and steam control range, without too much sacrifice in other desirable features, it would result in appreciable saving in cost and time for design, manufacture and erection of steam-generating units.

Views of Consulting Engineers

As would have been expected, there was less unanimity in views expressed by the designing engineers and the same applied to representatives of the operating companies, although among the latter there appeared a much greater disposition to accept some degree of uniformity.

The representative of one of the largest firms of consulting engineers stated that his company had found it possible to adhere, with occasional slight departures, to the Preferred Standards for condensing turbines installed within the last few years and aggregating around 650,000 kw capacity. He was of the opinion that complicated heat balances, designed to avoid degradation of energy, are usually not justified and that it is desirable to utilize the feed extraction points provided, regardless of pressure. Running up the feedwater temperature means increased throttle flow and extra heater surface, with little or no gain in overall economy.

Another designer, speaking for a well-known engineering firm that has installed approximately 750,000 kw of turbine capacity in units from 2000 to 160,000 kw during the last five years, stated that as long as the final feedwater temperature is not varied, it is of little consequence how the extraction points are varied within the range. He suggested that for capacities up to 2500 kw, two extraction points were sufficient but favored four extraction points for units of 10,000 to 80,000 kw; above that the case is special. He also believed that below 10,000 kw the deaerating cycle is just as good as the closed cycle and that it is desirable to have all the heaters of the same size to simplify arrangement. His company had followed the Preferred Standards rather closely, except in a few cases where departures were necessary.

On the other hand, several designing engineers expressed adverse opinions. One, while opposed to any limitation in the number of heating stages, believed that the extraction pressures were less important and could not see where any standardization could be applied to the evaporators.

A second engineer stated that his company had not found it possible to follow the extraction temperatures recommended by the Preferred Standards, and had generally found it advisable to employ more extraction points and higher feedwater temperatures than those prescribed. In one case of a 3000-kw unit, four stages of extraction had been employed. He advocated the maximum number of bleed points where fuel costs are high and considered load factor most important. In one central station these considerations had dictated the use of six bleed points. Recent investigations had indicated further possibilities in the regenerative cycle and he was adverse to any standardization of pressures or extraction points on the grounds that progress would be hindered.

A third discusser considered the matter as one of economics, keeping in mind all items of cost and the possibility of outage incurred by each extra piece of equipment. He believed that the deaerating heater could be placed anywhere in the cycle and produce equally good results, but that its location will affect its cost, as a low-pressure heater means more surface, whereas a high-pressure heater means a heavier shell and greater heat storage. Also, a high-pressure heater offers the possibility of flashing with a sudden drop in load and consequent chance of damaging the pump. He was adverse to standardizing on turbine bleed points because of variation in fuels which, because of sulphur content, often dictated the stack gas temperature.

Operating Viewpoint

It was pointed out that the practice of one company operating a number of central stations had both antedated and closely followed the Preferred Standards. Pressures and temperatures had been standardized and a simple heat-balance cycle, with three extraction heaters, had been employed to advantage. Its representative believed the proposed temperature of about 215 F in the high-pressure heater to be very desirable, although a temperature of 290 F for the third heater would prevent corrosion in the economizer.

Another central station engineer was strongly in favor of some degree of standardization and believed that many who are now opposing the idea will eventually come around to it if they will make an honest endeavor to face all the facts. He mildly criticized the manufacturers for being too willing to fall in line with suggestions from customers, regardless of whether such suggestions are well founded. He was of the opinion that too much stress is often laid on thermal rather than overall economic efficiency, or dollar economy, and that a slight gain in thermal efficiency is frequently more than offset by extra cost. A further suggestion was that the manufacturers get together and tell the field what it can have, just as has been done in many other lines.

This viewpoint was largely endorsed by another central station representative who added that, in view of present and probable conditions facing the utilities, dollar economy must carry still greater weight. He was in favor of standardization within certain limitations and advocated four-point extraction for 50,000-kw units.

Answering a specific question, another discusser did not consider separate deaerators necessary for pressures of 800 to 900 lb and stated that his company had selected 815 lb at the throttle to avoid getting within the 1500-lb standard, when considering the drop through the piping and superheater. The extraction points and tempera-

tures employed were in agreement with the Preferred Standards.

Standardization in any form was opposed by another utility engineer largely on the grounds that it would not fit in with conditions in existing stations.

Further Study Recommended

Inasmuch as the Preferred Standards had necessarily been compiled hurriedly by a relatively small committee to meet pending war conditions, it was the concensus of the meeting that they warranted further study, in light of the views expressed; and that with some modifications it might be possible to arrive at recommendations that would be generally acceptable and could be followed in all but special cases. To this end, the matter was referred to Council with the suggestion that a committee be appointed for this purpose.

Spreader-Stoker Firing

Recent developments in spreader-stoker firing were discussed in a paper by **R. L. Beers,** Vice President of the Detroit Stoker Company. These include power-operated dumping grates, to permit more rapid cleaning, and divided ashpits to provide a separate chamber for each feeder and each section of grate, so that in cleaning one section of grate the air and coal supply can be cut off without interfering with the other sections. This reduces excess air in the furnace.

For larger boilers and higher burning rates it is desirable to increase the furnace turbulence by introducing over-fire air. As to cinder and fly ash carryover, while low draft-loss cinder traps have been satisfactory with natural draft, where induced draft is employed a cyclone form of trap or cinder-separating fan has been found most effective. For conveying cinders back to the furnace for reburning a high-pressure fan has proved more satisfactory than steam jets.

The author described the continuous cleaning type of grate having lapping non-sifting joints, and discharging the ash at the front. This grate travels forward at a much lower speed than the conventional chain-grate stoker; that is, its function is only to discharge the ash without regard to feeding the necessary amount of coal. For a low-ash coal of about 8 per cent ash and a burning rate of 60 lb per sq ft per hr, the rate of travel would be less than two feet per hour. Of course, for a higher ash coal the speed would be proportionately greater.

Heat releases below 35,000 Btu per cu ft of furnace are advisable for best results and while some installations are in operation with preheated air temperatures of 400 F, judgment should be used to carry lower temperatures with coals having a low-fusing temperature ash. Except for small installations, water walls were recommended to prevent high refractory maintenance. However, only sufficient cooling should be employed to protect the walls.

With spreader firing, it was pointed out, smoke will result if too much coal is fed into the furnace for the amount of air supplied, but this can be quickly eliminated by increasing the ratio of air to coal, assuming that the heat release is not excessive or the combustion rate too low for maintaining ample furnace temperature. Owing to the sensitiveness, or quick response to changes in the ratio of coal and air, automatic combustion control is most desirable.

The paper included typical test results and illustrated one six-unit installation with a continuous-cleaning grate applied to a boiler having a rated capacity of 210,000 lb of steam per hour, but upon which loads up to 225,000 lb per hr have been carried with Indiana coal averaging about 10,500 Btu per lb. Daily efficiencies of approximately 83 per cent are obtained at a combustion rate of about 65 lb per sq ft of grate.

In the discussion of this paper it was emphasized that, in addition to affording increased capacity, the spreader stoker permits a much wider selection in the choice of coals; also that automatic control is most desirable and that there is still room for improvement in the control of over-fire air. Experience had shown that, in general, new operators assimilated the features of spreader-stoker firing more readily than those who had been trained in firing other types, although the latter, once they had grasped the principles, soon became proficient and enthusiastic advocates of spreader stokers.

Answering questions raised in the discussion, the author stated that the air space should be from 2 to 3 per cent of the grate area; that preheated air, protected walls and relatively short flame were most desirable; and that for marine installations the dump-grate offered the most foolproof method of ash removal.

Centrifugal Pump Performance

At the Hydraulics Session on Thursday morning **A. J. Stepanoff,** development engineer of Ingersoll-Rand Company, presented a paper on "Centrifugal-Pump Performance as a Function of Specific Speed." The author's conclusions were as follows:

1. The optimum gross pump efficiency of centrifugal pumps varies with the specific speed, reaching a maximum at specific speeds of 2000 to 3000 for double-suction pumps.

2. Hydraulic losses decline sharply up to specific speeds of about 2000 and then rapidly increase.

3. Disk-friction loss and leakage loss, expressed in percentage of pump output, do not depend upon pump size and speed.

4. A definite relation exists between disk friction and leakage losses and specific speed.

5. Friction coefficients for the calculation of the flow through the annular clearances have been compiled and plotted against Reynolds numbers. These are independent of the length of the throttling surfaces, their diameters and the clearance.

6. A study of losses at partial capacities with constant speed reveals the existence of "circulation" loss. This is a loss of power caused by relative internal circulation within impeller channels, and also from channel to channel. The loss is zero near the best efficiency point and is a maximum at zero capacity. It is greater with high-specific-speed pumps.

The author included various charts, particularly one showing actual hydraulic efficiencies as determined for pumps of different specific speeds.

(*Continued on page 46*)

1825-Lb-Pressure Topping Unit with special reference to Forced-Circulation Boiler

By F. S. CLARK,[1]
F. H. ROSENCRANTS[2]
and W. H. ARMACOST[3]

In view of previous publicity accorded this high-pressure C-E Controlled Force-Circulation steam generating unit, which is the first of its type to be installed in this country and which is nearly double the capacity of any installed abroad, the following abstract of a paper presented at the 1942 A.S.M.E. Annual Meeting will cover only the general considerations and such design details as have not heretofore been made available. Certain recent operating and performance data are also included. Because of current censorship regulations the name and location of the power plant cannot be divulged in the present paper.

THE power station is located on tidewater and up to the time of the present installation contained two turbine-generators of a combined capacity of about 75,000 kw and five boilers of approximately a million pounds per hour total steam-generating output. Steam conditions at the turbine throttles for the low-pressure plant are 375 psi and 750 F. These boilers are equipped to burn oil or pulverized coal.

Early in 1940 the Company requested Stone & Webster Engineering Corporation to undertake engineering and economic studies to determine the best type of capacity to be added, it being desired to improve the station economy as well as increase its capacity. As a result of these studies, it was decided to install a superposed turbine-generator capable of producing 25,000 kw continuously with one boiler of 650,000 lb per hr capacity at 1825 psi and 960 F at the superheater outlet. In combination with the two existing 375-psi turbine-generators the resultant gross output from the high-pressure boiler amounts to 72,800 kw.

The fact that at 1850 psi water at the boiling point weighs about 40 lb and saturated steam 4.75 lb per cu ft, presented a problem in connection with natural circulation in a low-head boiler (as dictated by the existing structure), having a distance from the bottom of the main drum to the furnace floor of about 60 ft. Studies of natural-circulation designs submitted left doubts, possibly unjustified, as to satisfactory operation under the conditions imposed. Therefore, after most thorough study, forced-circulation was decided upon. The design submitted was supported by experience with several hundred units operating in Europe, running in capacities up to 350,000 lb per hr. The fact that the new unit is the first of its type to be installed in this country and, when compared with European practice, is 85 per cent greater in capacity, is for higher pressure and higher steam temperature, and that it involves steam reheat, does not, however, place it in a sphere of radical pioneering.

The boiler (Fig. 1) differs in construction from a conventional natural-circulation unit in two fundamental respects: (1) Pumps, inserted in the downcomer connections from the main drum to the bottom furnace-wall headers, serve to insure the volume of circulation established by the design; and (2) an orifice, inserted at the entrance to each tube element at the point where it emerges from the bottom furnace-wall header, serves to fix the flow of water at a predetermined proportion of the total volume in circulation.

Operation of the boiler is uninfluenced by the forced- and controlled-flow features, the burners, draft system, feedwater regulation, blowdown, etc., being the same as would apply to a natural-circulation unit of comparable design. The circulating pumps introduce minor variations in the routine of placing the unit in service, but having been placed on the line, the attention required is no more than that given to the forced- and induced-draft fan units; in fact, it is less as no attempt is made to control the rate of delivery, either by throttling or speed control.

Circulating Pump Features

Two of the three 3500-gpm, 50-psi-head circulating pumps are dual-driven and so arranged that, if the speed drops to a predetermined value due to motor failure, the steam turbine picks up the load automatically. Two pumps will be in service at all times, so that at least one of the dual-driven pumps will always be in operation. With two motor drives in service, the source of electric power for each will be independent of the other. If, for any reason, the differential pressure between the suction and discharge headers falls to an established minimum, an automatic device acts to shut off the fuel supply.

The circulating pump impeller is of the simple overhung type and the shaft gland is packed against a pressure of 115 psi, the pressure being maintained by a re-

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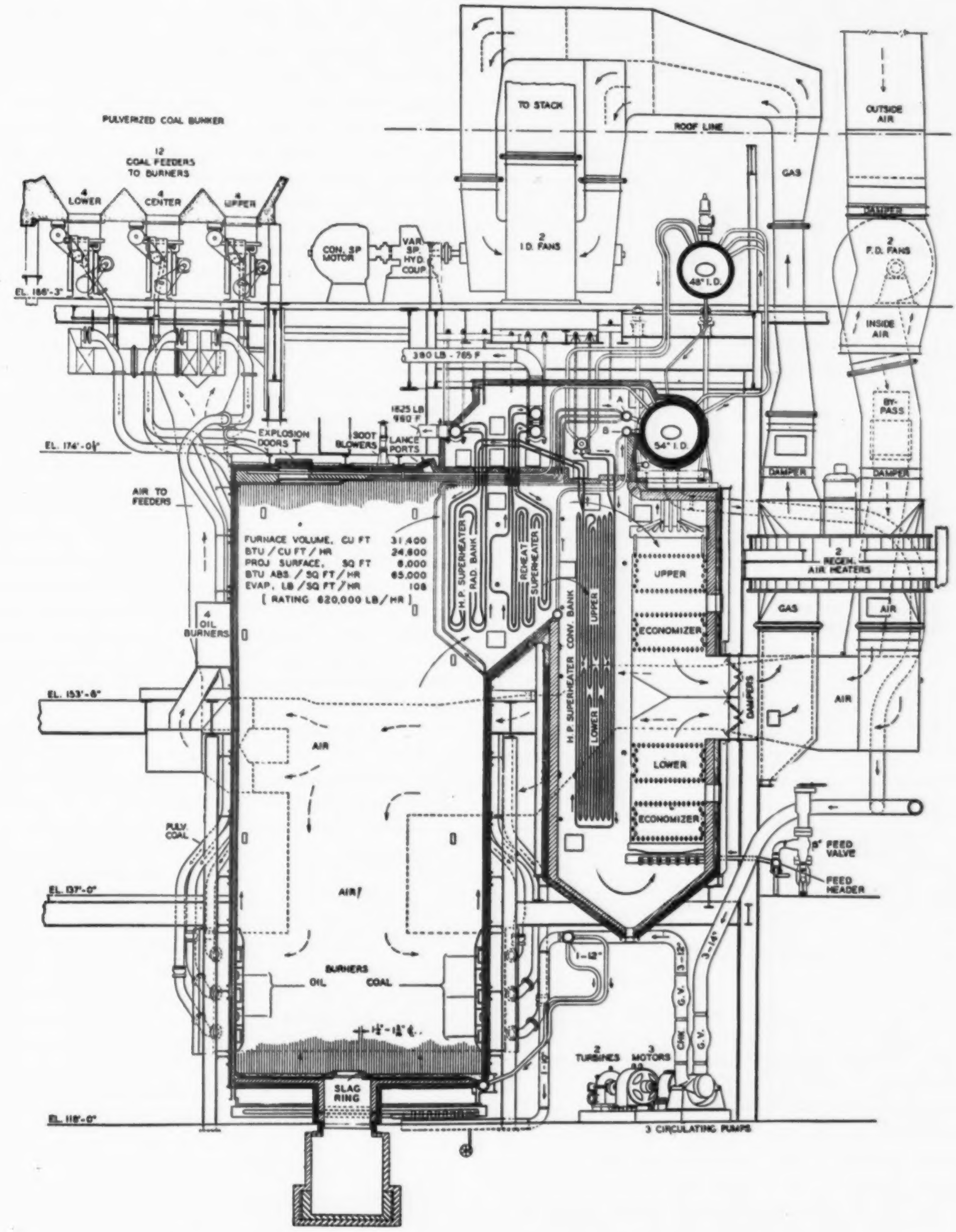


Fig. 1—Sectional elevation of C-E controlled forced-circulation boiler

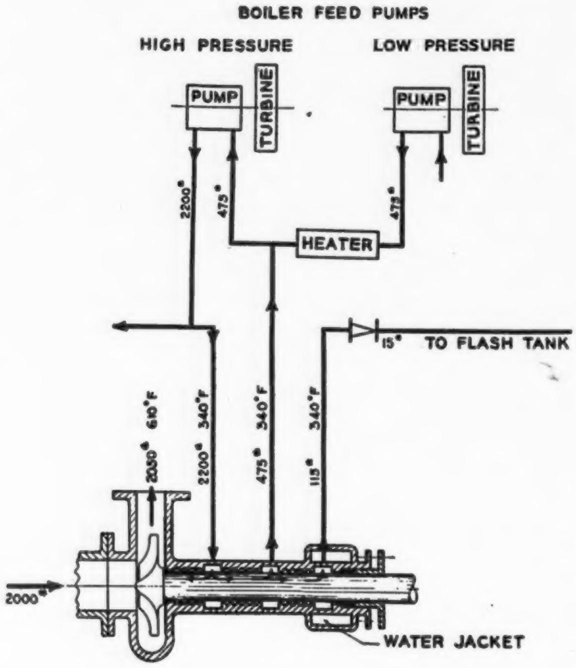


Fig. 2—Diagram of circulating-pump gland

ducing valve discharging to a 15-psi flash tank. Fig. 2 indicates the manner in which the 2000 psi is broken down and the means of taking care of leak-off water, a system identical with practice long established in high-pressure boiler feed pumps.

With two pumps in service the total water in the system is circulated in a period of 1 to $1^{1}/_{2}$ min, the exact time depending upon the level of water in the drum and the ratio of steam to water in the furnace walls.

Following are the main operating characteristics of the boiler with full load of 650,000 lb of steam per hour when firing pulverized coal:

Design pressure, psi	2000
Steam at superheater outlet, psi and deg F	1825 and 960
Steam at reheater inlet, psi and deg F	400 and 603
Steam at reheater outlet, psi and deg F	380 and 765
Feedwater temperature to economizer, deg F	446
Feedwater temperature to boiler, deg F	520
Final gas temperature, deg F	290
Total draft at air-heater outlet, in	10.85
Total air pressure at air-heater inlet, in	11.80
Efficiency of unit, per cent	89.3

Fig. 3 shows the heat-balance diagram for the high-pressure installation with the "topping" unit generating 25,000 kw. Under this condition, the boiler delivers 620,000 lb per hr of which 615,460 is exhausted from the turbine at 400 psi and 603 F. Of the exhaust, 77,500 lb is used in two crossover heaters as a final or third stage in feedwater heating. The remaining 537,960 lb goes to the reheater in the boiler setting where its temperature is raised to 765 F. Of the reheated steam 53,300 lb is used to drive the high-pressure boiler feed pumps. Approximately 500,000 lb, including tempering steam used for temperature control, passes into the header supplying the two existing generating units. This is sufficient for the generation of about 47,800 kw.

Exhaust steam from the high-pressure boiler-feed-pump turbines is used for the first stage of feedwater heating. The second stage of heating is with steam extracted from these same turbines at about 122 psi. Drips from the extraction and crossover heaters are pumped to the high-pressure boiler-feed-pump suction header.

Boiler Details

All furnace-wall tubing is $1^{1}/_{4}$ in. OD. At the point of leaving the bottom headers, a single $1^{1}/_{2}$-in. outlet is bifurcated into two $1^{1}/_{4}$-in. tubes and all spacing is arranged to give a furnace lining of $1^{1}/_{4}$-in. tubes on $1^{5}/_{16}$-in. centers. The only exception is that in front of the superheater where the $1^{1}/_{4}$-in. tubes are increased to $1^{3}/_{4}$ in. and arranged in two-in-line rows on $6^{9}/_{16}$-in. centers. The furnace tubing adds up to about 63,000 linear feet and on a projected basis the tubing exposed to heat is equivalent to approximately 6000 sq ft. This constitutes the entire evaporating surface and at 620,000 lb per hr output corresponds to approximately 108 lb evaporation per square foot of projected surface per hour. With water entering the circulating system at 530 F, the heat absorption per square foot of projected heating surface per hour is about 65,000 Btu.

The convection bank of the high-pressure superheater, of 24,371 sq ft, is made up of $2^{1}/_{8}$-in. tubes with the elements spaced on $3^{9}/_{32}$-in. centers across the boiler. The radiant bank, of 3212 sq ft, which is next to the furnace and arranged so that loops carrying the coolest steam are closest to the hottest gases, is made up of 2-in. tubing on $6^{9}/_{16}$-in. centers in line with the $1^{3}/_{4}$-in. furnace screen tubes. Located between the radiant and convection banks is the reheat superheater having $2^{1}/_{8}$-in. elements on $6^{9}/_{16}$-in. centers. This reheat surface is 4381 sq ft.

The economizer, of 25,854 sq ft, is made up of 2-in. multiple-loop finned elements. It takes water into two bottom headers through a total of fourteen $3^{1}/_{4}$-in. tubes and discharges from two top headers through a total of eighteen $3^{1}/_{4}$-in. tubes into the bottom of the drum. Elements run from both sides to the middle; that is, there are actually two sets of economizers through which gas flow is controlled by dampers at the outlet.

The main steam drum, which is 41 ft $3^{1}/_{2}$ in. long by 54 in. inside diameter, has a plate thickness of $4^{23}/_{32}$ in. The dry drum is 24 ft 2 in. long by 48 in. inside diameter and is $4^{3}/_{16}$ in. thick. The manner of entering the tubes into the drums is shown in Fig. 4 and is such as to provide a ligament efficiency of 90 per cent. A total of 66 tubes $3^{1}/_{4}$ in. diameter take the steam from the main steam drum to the dry drum, and 40 tubes of the same diameter convey the steam from the dry drum to the saturated steam header of the high-pressure superheater. These are indicated in Fig. 5 which also shows the drum internals.

Two regenerative-type air preheaters, of 55,200 sq ft each, complete the heat-absorbing equipment.

Materials Employed

Materials employed for the pressure parts include 70,000 T.S. molybdenum steel for the drums; silicon-killed medium-carbon steel for the drum assemblies (except nipples which are forged steel), for the circulating system (excepting the distribution header under the furnace), for wall headers (excepting bottom rear header and connections) for tubes from upper side wall header to drum and upper rear wall header to header B, Fig. 1, for the inlet to the high-pressure superheater header and both inlet and outlet of the reheater, and for the econ-

omizer headers, economizer outlet header to drum, and feeder header to inlet header. Silicon-killed low-carbon steel is employed for the furnace connections at headers, for the water-wall tubes, the screen tubes below the superheater, the bottom half of the high-pressure convection superheater bank and the finned economizer tubes. The high-pressure superheater loops nearest the furnace and the finishing loop are of chrome-molybdenum-titanium steel; the orifices are of stainless steel, and the top half of the high-pressure convection superheater is of silicon-killed carbon-molybdenum steel. Low-carbon steel is employed for the reheater tubes.

All tube connections to headers and to drums are welded, there being no rolled joints. This involved 2720 field welds in addition to those made in the shop. The only joints that are not welded are the plugs opposite the orifice and strainer assemblies, the manholes in the drums, the bolted joints on the safety-valve flanges, the bonnets on the circulating-water-pump valves and the heads on the circulating pumps.

Soot blowers are located in the furnace roof and walls, the superheater and reheat sections on each side of the boiler and in the economizer section. All the furnace units take steam at 750 psi through a reducing valve and the remaining soot blowers take steam from the reheater outlet at 375 psi, 750 F. Access for hand lancing of the screen and superheater section is provided by a row of lancing ports in the roof.

The surfaces, temperatures and distribution of heat absorption, when operating at an output of 620,000 lb per hr are indicated in Fig. 6.

Control of high-pressure steam temperature is obtained by controlling dampers regulating the quantity of flue gas passing over the high-pressure convection superheater. These dampers are automatically controlled in parallel with the rate of air flow through the boiler unit with automatic readjustment from a thermostat in the high-pressure-steam outlet header. By design, full superheat, with coal as fuel, is available down to a rating of 480,000 lb per hr.

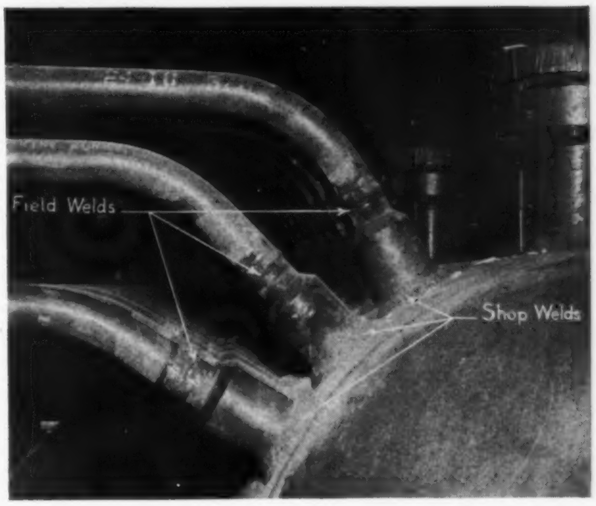


Fig. 4—Means of reinforcing drums at tube entrance; the large tubes go through the drum plate and are welded inside and out

Reheat temperature is automatically limited by the injection of saturated steam from the saturated zone of the crossover feed heater into the steam line leading from the reheater. In the event that the high-pressure turbine is bypassed, the steam temperature to the reheater is reduced by spraying water under automatic control into the steam line leading to it. The temperature of either the high-pressure or the reheated steam may be boosted by burning the required amount of oil in the upper burners under control of manually operated devices located on the operating panel.

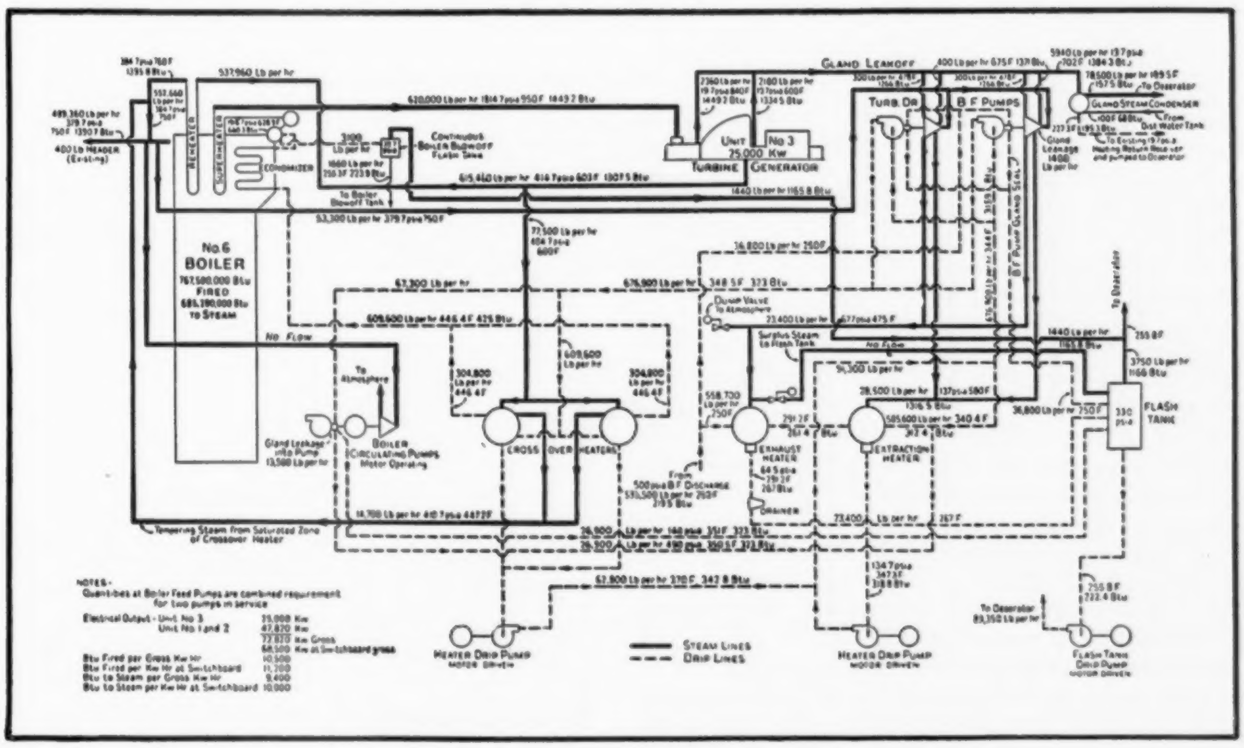


Fig. 3—Heat-balance diagram for high-pressure installation

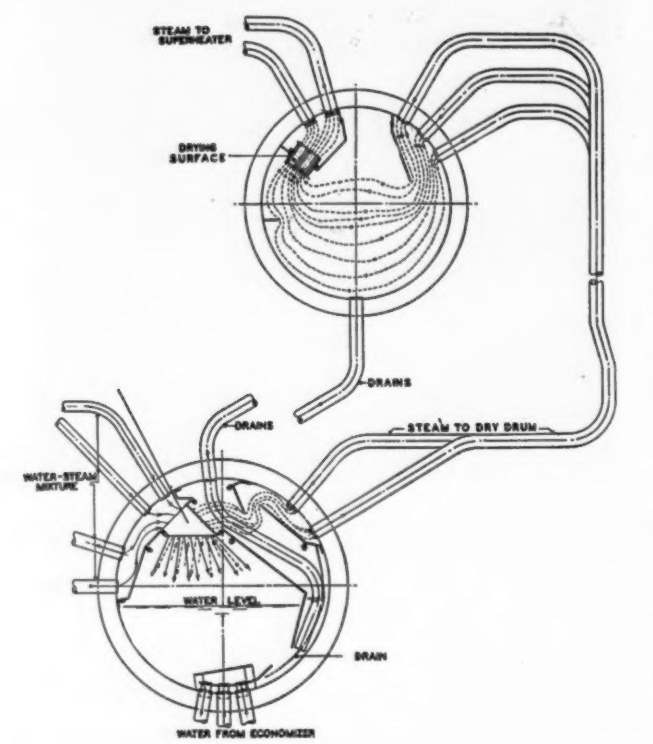


Fig. 5—Connections between main steam drum and dry drum

The unit is fired with twelve (3 sets of 4) pulverized-coal burners, or alternately, by eight (2 sets of 4) oil burners, all arranged for tangential firing. These are supplemented by the four auxiliary oil burners located in the upper front wall opposite the superheater for boosting the superheat when necessary. The pulverized coal is supplied through feeders from the existing detached pulverizing plant.

Operating Record

The turbine-generator became available for actual operation under load on October 16, 1942. Since that date, the unit has been in practically continuous operation with pressure and load gradually increased, although neither the boiler nor the turbine by November 20 had reached full design conditions. At that time the unit was carrying 17,500 kw and operating at a throttle pressure 1725 psi. The boiler output was 480,000 lb per hr. It was considered unsafe to carry a higher load at the time, because the bypass reducing valve had not proved reliable under full automatic control. If the turbine tripped out, failure of the reducing valve to operate immediately would have caused a loss of load on the low-pressure units in the station, with the possibility of a complete station shutdown. The valve manufacturer is working on this and the difficulty should be eliminated at an early date. Only one of the two feedwater level regulators is at present in reliable operation and this has also been a handicap to full-load, full-pressure operation.

The boiler was available for preliminary operation for some time before the turbine and this afforded an opportunity to discover and correct defects and to make necessary adjustments by operating over a wide range of output, supplying steam to the low-pressure turbine-generators through the reducing valve. The major troubles encountered were leaks in auxiliary equipment, such as valve bonnets, and carryover from the main drum to the dry drum under conditions of high water and high concentration. Modifications were made to the drum internals and there has been no subsequent difficulty from this source.

The design of the replacement drum internals had its origin in a research program carried on for some years and still continuing in response to the more and more rigid demand for cleaner and still cleaner steam for service with high-pressure turbines. During the period intervening between the original design of the internals and the date of placing the unit in service very definite improvements were developed, and these were applied to this boiler as soon as entirely new internals could be constructed and installed.

There has been one tube failure. This was a pressure failure due to defective tube metal, there being no evidence of overheating. A section about five feet in length was cut out and a replacement section welded in. The tube failure was a wide open rupture and the fact that water level was maintained in the drum until the furnace was partially cooled is a point of interest.

The principal valves in the circulating system have ring-gasket bonnet joints. It has been necessary to replace all of the original oval rings with octagonal rings and since this replacement no leaks have been experienced. No major leaks have occurred in the boiler or circulating system, except a dozen or so of the plugs opposite the screen and orifice assemblies at the lower furnace-wall headers and at the flanges on the heads of the circulating pumps. These, however, were made tight without reducing pressure or capacity. No leaks have occurred on any welded joints and none on the manhole covers or the safety valve flanges.

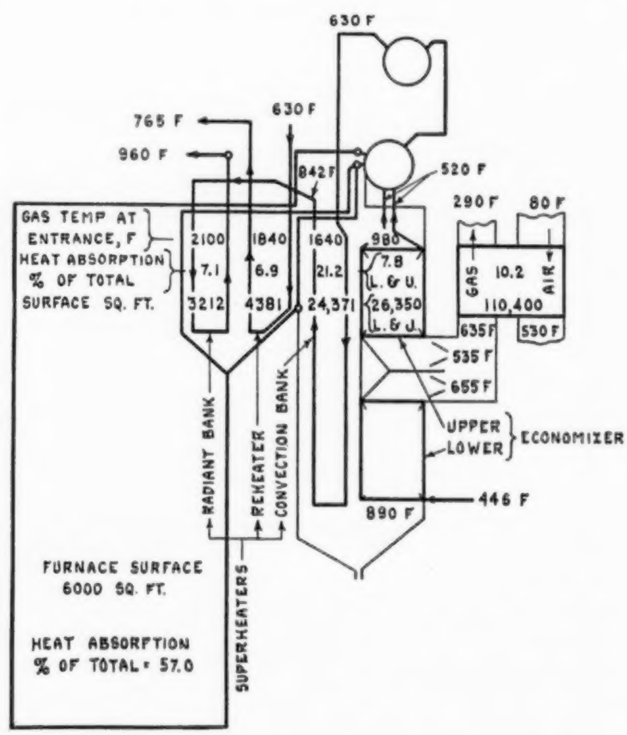


Fig. 6—Surfaces, temperatures and distribution of heat absorption at 620,000 lb per hr rating

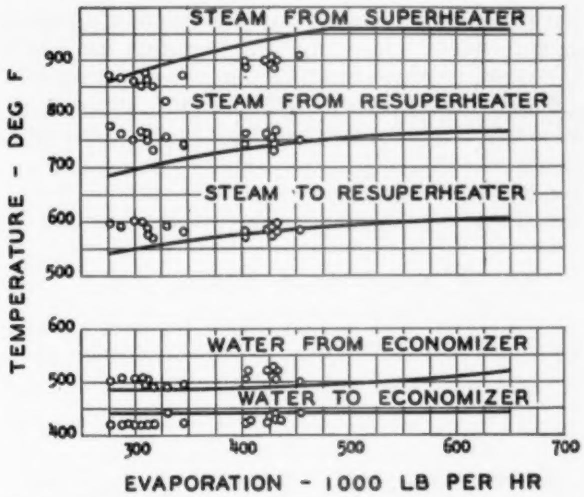


Fig. 7—Anticipated and observed temperatures of steam and water

Some difficulty was experienced with the labyrinth packing on one of the three circulating pumps, necessitating replacement. During preliminary operation it was found necessary to lap in the high-pressure safety valves and the water column fittings in order to make them tight at full pressure.

Performance

No official tests have been run. Curves, Figs. 7 to 9, show anticipated values of the functions plotted and the points recorded thereon are values observed in normal operation. All readings were taken after several hours' operation at substantially constant load and as nearly simultaneously as possible. Temperature readings are by thermocouples, the accuracy of which was carefully checked. Fig. 10 shows the position of the three sets of dampers used in the control of superheat and outlet gas temperature as observed during actual operation.

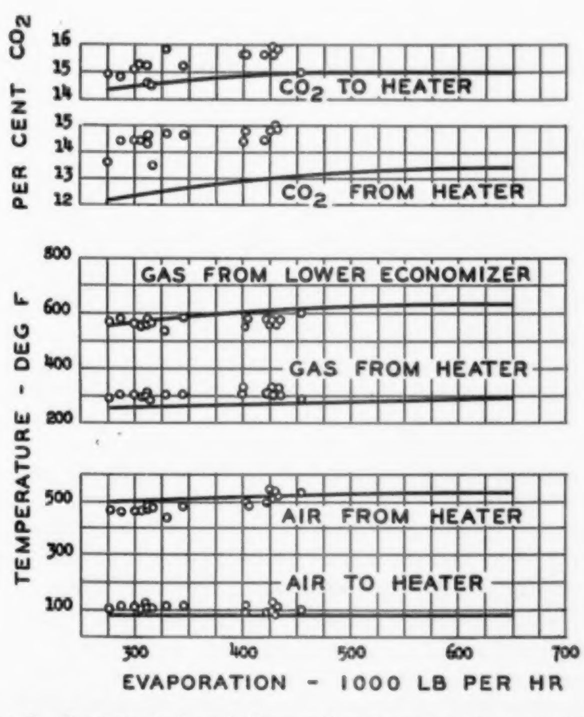


Fig. 8—Anticipated and observed gas temperatures and CO_2

The values shown in Fig. 10 should be carefully considered when studying the values of superheater outlet temperature, gas and air outlet temperatures from the air heater, draft at air heater outlet and air pressure at air heater inlet. A wide range of control is possible through manipulation of these dampers. Referring to values taken at the 425,000-lb rating, it will be observed that the upper economizer outlet damper, referred to in Fig. 10 as "Superheater Bypass" damper, is 100 per cent open and the lower economizer damper is just over 40 per cent open. To obtain maximum superheat, the openings would be 0.0 per cent and 100 per cent, respectively. Such a setting would result in a temperature substantially above the anticipated curve value and incidentally reveals that full superheat is attainable at ratings substantially below the rating of 480,000 lb per hr, the lowest rating at which full superheat of 960 F was

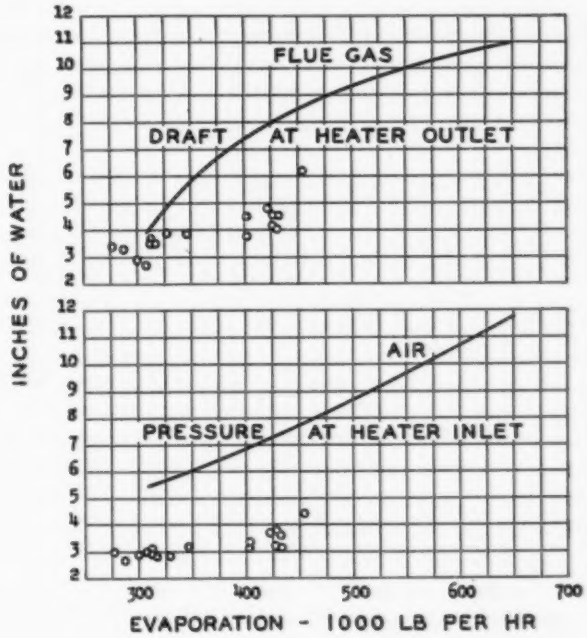


Fig. 9—Draft at air preheater inlet and outlet

guaranteed. This extreme position of damper setting would also result in a substantial increase in draft at the air heater outlet. It will also be noted that at the 425,000-lb rating the air-heater air-bypass damper is 70 per cent open. The purpose of this is to maintain the outlet gas temperature up to approximately 300 F and avoid all possibility of corrosion or deposits at the cold end of the air heater elements. This results in a reduction of air pressure at the air heater inlet. A comparison of the gas and air temperature ranges between air heater inlet and outlet indicate that about 20 per cent of the total air is being bypassed.

The air pressure observed at air heater inlet is substantially less than indicated on the curves of anticipated performance. It should be stated, however, that in addition to the influence on this value of bypassing air around the air preheater that the air pressure at the burners was predicated on the requirements of the oil-burning equipment. Actual operating experience does not dictate the desirability of utilizing the full available pressure when burning coal. The fact that somewhat more gas

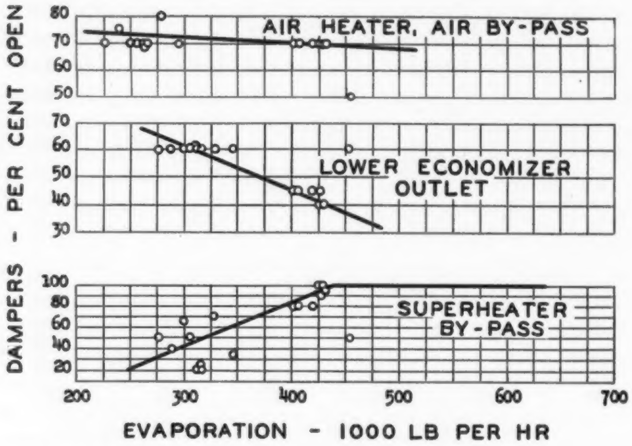


Fig. 10—Damper positions plotted against output

is bypassed around the large convection superheater than was allowed for in proportioning the induced-draft fan accounts in some measure for the low value of induced draft as compared with anticipated values shown by the curves.

Many determinations of conductivity of steam samples taken simultaneously at entrance to the dry drum and from the saturated superheater header have been made. Under conditions of normal water level and with boiler-water concentrations corresponding to conductivity up to 2600 micromhos (about 1300 ppm) the conductivity of a sample at the entrance to the dry drum has, in no instance measured, exceeded 2.5 micromhos with normal values about 2.1—both uncorrected for dissolved gases. The corresponding values in the saturated header have been only slightly less, showing that practically all separation took place in the main steam drum. By deliberately increasing the water level to a point 6 in. above normal, conductivity values at entrance to the dry drum up to 27 micromhos have been measured with no increase, however, in values measured in the saturated header. Conductivity of samples from the saturated superheater header which had been incompletely degasified showed values under one micromho corresponding to something under 0.5 ppm.

It seems reasonable to presume that had external obstructions permitted a more favorable steam take-off from the main drum and the installation of drying screens in this drum, that equal values of steam quality would have been obtained without the dry drum installation.

The heat balance constructed for the 425,000-lb rating using observed temperature data, CO_2, etc., and based on a West Virginia coal of 18 per cent volatile content, shows the following losses and efficiency:

Dry gas loss	5.20 per cent
Hydrogen and moisture loss	3.20 per cent
Moisture in air loss	0.14 per cent
Carbon loss	0.50 per cent
Radiation loss	0.46 per cent
Total loss	9.50 per cent
Indicated efficiency by difference	90.50 per cent

In general, the observed performance reveals that the proportions of all elements of the heat absorption equipment and that the capacity of forced- and induced-draft fans are on the generous side; also, that the range of control provided permits regulation of important temperature values to the anticipated performance with some margin to spare. The period of operation has not been long enough to give assurance that all operating difficulties have been overcome but, thus far, troubles which have arisen have not been such as to cause concern for the future.

Facts and Figures

In some large high-pressure, high-temperature steam-generating units the overall vertical expansion of pressure parts, from cold to operating condition, is as much as 4 in.

•

With blast-furnace gas the weight of the products of combustion for a given steam output is almost twice that with rich fuels, such as coal, natural gas or oil.

•

It has been authoritatively estimated that the average load factor on electric generating stations will have increased about two per cent this year over that prevailing in 1941.

•

In general, the capacity of a centrifugal pump varies directly as the speed and the total head as the square of the speed.

•

With slagging bottom furnaces it is generally considered that around 50 per cent of the ash in the coal is deposited in the bottom of the furnace with the molten slag.

•

A large high-pressure high-temperature steam-generating unit recently established a performance of operating 99 per cent of the total time for 11 months at an average of 85 per cent of maximum load.

•

The average temperature of gases in their passage over superheating surface decreases about 2.7 to 3 deg for each degree increase in steam temperature. Hence a difference of about 30 deg in the gas temperature may cause the steam temperature to fall outside the usual tolerance limit of plus or minus ten per cent.

•

The amount of heat given up to the condensing water by a 50,000-kw condensing unit, if run at full load for 24 hr would be sufficient to heat from 40 to 45 six-room houses during an entire heating season, or about eight hundred such houses for one day.

•

According to figures compiled and recently released by the Federal Power Commission covering privately owned electric utilities for the year 1941, the average production expense for steam power was 32 per cent of the total expense, or 13.7 per cent of revenues. Transmission expenses amounted to 3.2 and 1.4 per cent respectively; distribution expenses 17.8 and 7.6 per cent; accounting, collections and sales promotion 12.2 and 5.2 per cent; and administrative and general expenses 13.9 and 6 per cent. Commercial and industrial load accounted for 56.9 per cent of the total load, but residential customers, while representing over 80 per cent of the total number, accounted for only 12.9 per cent of the load.

Combustion Control for Spreader Stokers

By H. G. MEISSNER

Stoker Eng'r'g Div., Combustion Engineering Co.

The purpose of this article is to point the way to securing maximum service from spreader stokers, by acquiring a knowledge of the control equipment which has important bearing on successful operation. Practical suggestions on handling this type of stoker are also included.

CONTRARY to popular belief the spreader stoker is one of the oldest types of mechanical firing on the market, having been known and used to some extent as far back as the middle of the last century. However, it was not really accepted as an efficient high performance stoker until the use of large air space, natural-draft grates was discarded, some 15 years ago, in favor of small air space (2 to 3 per cent) grates and forced draft. The earlier models were built by relatively small, local companies, and it was not until several of the better known stoker manufacturers developed well-designed models, carefully engineered and installed in furnaces of ample size, that their popularity became nationwide.

Their ability to burn satisfactorily practically any of the solid fuels produced in this country, from lignite through the various grades of bituminous coal to coke breeze on the opposite end of the volatile scale, has fitted in particularly well with the present war effort, and many of our army camps as well as other wartime boiler plants are being fired by spreader stokers.

These stokers are now built in sizes ranging from those suitable for domestic heating boilers, to units firing boilers having a steam output of close to 250,000 lb per hour. The range of control equipment includes, therefore, the simplest type of thermostatic or pressure regulation and the most efficient and up-to-date types of combustion control, as outlined in the following pages.

The desirability of automatic combustion control for spreader-stoker-fired boilers becomes apparent when the characteristics of this method of firing are fully understood. The very features which have helped to make this type of stoker so popular in recent years require that fuel, air and draft conditions be carefully regulated at all times, to ensure efficient and smokeless operation.

Spreader stokers employ overfeed firing, the green fuel being distributed uniformly on top of the already burning fuel bed. The fines burn in suspension, and the larger particles are consumed on the grate. The active fuel bed is very thin, usually about $^3/_4$ in. in thickness, and there is seldom more than a minute's supply of fuel in the furnace. Fig. 1 represents a typical spreader-stoker-fired furnace.

Coal Sizing

To make it possible to maintain this thin fuel bed, the coal sizing must be generally below $^3/_4$ in., with few larger lumps. An excess of slack increases the suspen-

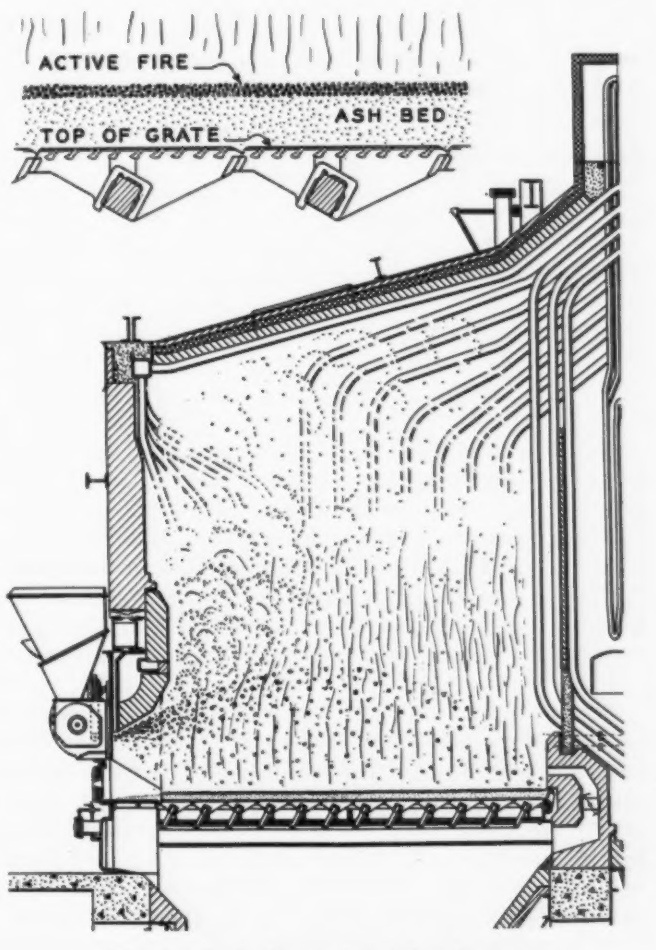


Fig. 1—Typical spreader stoker furnace
Note uniform distribution of the larger fuel particles on the grate, and suspension burning of the fines at the front

sion burning and cinder loss somewhat. Three-quarter inch nut and slack is therefore the recommended sizing, although "bug dust" and similar sizes are frequently used satisfactorily.

The response to load changes is very rapid, because of this thin fuel bed, the spreader stoker being in this respect similar to pulverized coal rather than to underfeed or traveling-grate firing. The effect of variations in the fuel-air ratio is also quickly apparent, an excess or deficiency of air being almost instantly shown by a drop in the CO_2, or smoke, as the case may be.

The overfeed firing and thin fuel bed eliminate any coking or caking tendencies of the fuel, because of the rapid distillation and combustion of the tarry hydrocarbons and the absence of overlying masses of partly coked fuel to which to adhere. Coking, caking and free-burning coals can therefore be burned with equal facility. This rapid distillation of gases necessitates an ample and well-distributed supply of air through the fuel bed, to avoid incomplete combustion and smoke.

lation of furnace draft as well as forced draft, since both affect the total air and resultant gas volume and velocity.

The simple, archless type of furnace in which the spreader stoker is usually installed, ensures minimum first cost and maintenance, but obviates any possibility of mechanical mixing or turbulence of the gases after they leave the fuel bed, such as occurs in the double-arch furnace of the conventional traveling-grate stoker. This necessitates complete and rapid mixing of the gases and air, in and immediately over the fuel bed, which is obviously impossible unless the correct amount of air is supplied at all times.

Overfire Air

Overfire air is effective, but it must be used with discretion, so that the air supplied through the fuel bed will not be reduced to the trouble point. As a rule, not more than 5 per cent of the total air should be introduced over the fire at the maximum continuous load. As the primary function of overfire air should be to promote

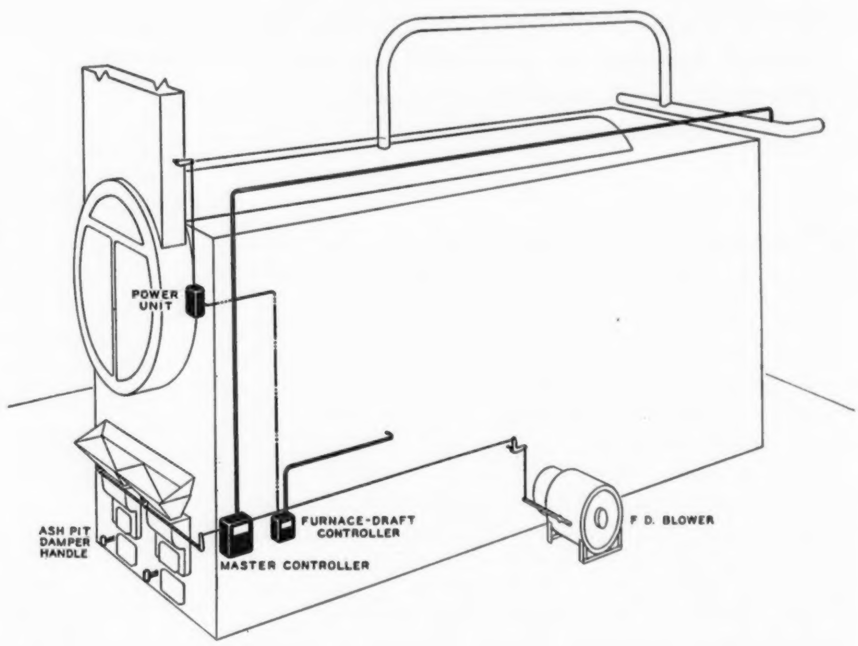


Fig. 2—Positioning type control

The "master" adjusts the fuel and air supply to meet load requirements, and the furnace draft controller positions the uptake damper to maintain desired furnace draft

The thin, non-agitated fuel bed always on top of the ash, practically eliminates clinker formations in the fuel bed. In fact, it is the absence of heavy clinkers which makes it possible to maintain a level fuel bed, as any interference with air flow quickly results in irregular fires and poor operation. Similarly, any reduction in the total air supply, below that required to complete combustion, will cause fuel bed build-up, clinkering and smoke.

Because part of the fuel is burned in suspension and never reaches the grate, a considerable proportion of the ash and partly burned fuel, usually called cinder, leaves the furnace and drops out in the boiler passes, or is discharged from the stack. This cinder carryover represents a direct heat loss, and may be cause of complaints from neighbors; hence it must be kept under control. The velocity of the gases through the furnace and boiler materially affects the amount of this cinder carryover, and to ensure that this velocity is held to a minimum, close control of the air supply is essential. This requires regu-

turbulence, high velocity and correct placing of the jets to ensure adequate penetration is necessary. Both high-pressure air, at 12 to 14 in. in the duct, and steam jets have been used with success.

Many up-to-date furnaces now employ cinder recovery equipment to return the cinders from the rear passes of the boiler and cinder traps to the furnace. The cinder-recovery-system nozzles are quite generally introduced through the rear or side walls, it being desirable to avoid elbows and long runs of pipe. Any additional overfire air deemed necessary should, therefore, be introduced through the front wall, immediately over the arch, to mix with and aid in the combustion of the gases from the fine coal burned in suspension at this part of the furnace.

Considering the foregoing conditions, it is apparent that the fireman would have to be a superman to keep the fuel, air and draft conditions constantly in balance by manual control, except when the load on the boiler happened to be very steady. The desirability of, and in

fact the necessity for, automatic combustion control is therefore evident if efficient, smokeless operation is to be maintained in everyday service. The next question then is: What type of combustion control should be used?

Types of Automatic Control

Probably the simplest form of control, aside from the thermostat type, is that called the "start and stop" or "on and off" system which stops the stoker and forced-draft fan when the steam pressure reaches the upper limit, and restarts them when the pressure drops to the lower setting of the pressure switch. In this system it is necessary that the fuel feed and forced draft be set at a point somewhat above that required to carry the maximum load on the boiler, so that when the lower limit switch cuts in, the heat input will be such as to increase the steam generation sufficiently to bring the pressure back to normal, without undue delay.

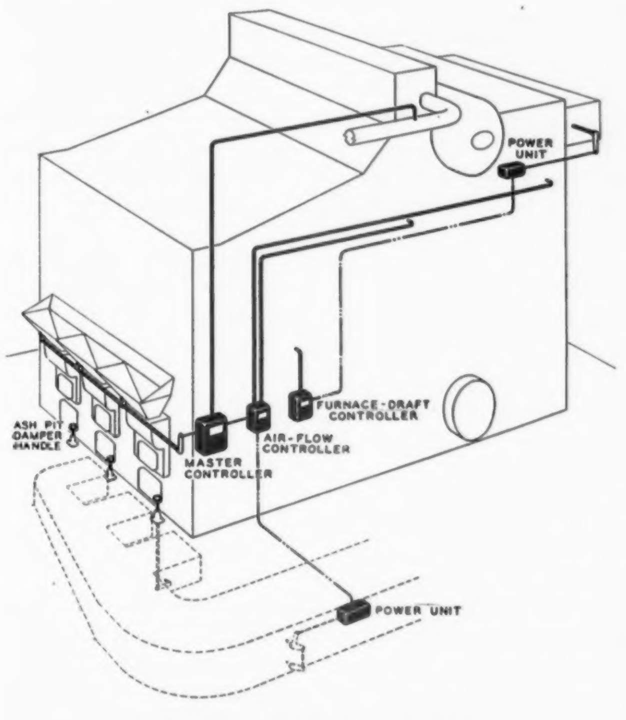


Fig. 3—Metering type control

Note that the "master" positions the fuel feed and air flow controller mechanism to meet load requirements, the air flow controller then adjusting the forced draft, and the furnace draft controller positioning the uptake damper to restore equilibrium

The heat input of the stoker and furnace are therefore never in step with the boiler output; that is, it is too high when the control is on and too low when the stoker and fan are shut off. The fuel bed is likely to burn out during the "off" period, so that when the fuel and air are again "on," slow ignition, smoke and high excess air are experienced. While satisfactory for stokers such as the single-retort underfeed, with its relatively thick fuel bed, this system of control is normally not recommended for spreader stokers and therefore is not here illustrated.

The "high low" or "two-speed" control, used to a considerable extent on underfeed stokers, has been tried on spreaders, with indifferent success. While it maintains a continuous flow of fuel and air to the stoker, the high rate must be above that required to carry the maximum load, and the low rate must be somewhat below that covering minimum requirements. Here again the rate of heat generation is never in step with the boiler output, so that optimum performance is impossible, and it is normally not recommended.

Positioning-Type Controls

"Positioning-type" controls, as shown in Fig. 2, adjust the fuel and air rates to conform closely with the boiler output, by means of a "master" which is actuated by steam pressure, and a furnace-draft controller which adjusts the uptake draft to maintain proper furnace conditions. For any given load the "master" takes a definite position, such that the fuel and air supply are just sufficient to match the steam output. By careful initial setting and occasional readjustment to correct for changes in fuel, etc., this type of control will maintain reasonably correct fuel-air ratios over the normal load range.

Power for actuating the individual coal and air supply, and draft control levers, is supplied by air, water or oil under pressure, or by electric motors, depending on the particular make of regulator. In the illustrations the "master" is assumed to have an integral power unit.

Positioning controllers are in general simple, reliable, easily understood and adjusted, and probably the most satisfactory type for the smaller plants or where skilled operators are the exception rather than the rule.

Metering Controls

The "metering or proportioning" type control is capable of providing test performance in everyday operation, when thoroughly understood and intelligently used. The gas flow through the boiler is metered by balancing the pressure drop or draft loss through an orifice such as the boiler passes, air heater, etc., across a spring or weight-loaded diaphragm, bellows or float. This resistance varies as the square of the gas or air flow, and serves as an accurate measure of the rate of flow. For any given position of the "master," the rate of coal feed is fixed, as is the spring loading of the air-flow controller. Movement of the diaphragm and attached linkage causes the power unit to regulate the uptake draft or forced-draft supply, to suit in accordance with previously made calibrations.

In this discussion no particular type of controller is indicated, there being a wide variety of designs involved; but the principle of the various types is the same. All should have provision for manual adjustment of the fuel-air ratio, to compensate for variations in coal, load conditions, etc.

In one form of metering control, that shown in Fig. 3, the steam pressure actuates, through a spring or weight-loaded diaphragm or bellows, the "master" which positions the fuel-feed mechanism to suit the boiler load and steam pressure requirements. The "master" also resets the air-flow controller to move the forced-draft fan damper to suit the requirements. The furnace-draft controller then readjusts the uptake damper or the induced-draft fan, so that draft conditions are restored to normal. For example, a drop in steam pressure causes the "master" to change position to increase the rate of coal feed

and tighten the air-flow controller spring. This controller then increases the forced-draft fan setting. The resultant drop in furnace draft causes the furnace-draft controller to increase the uptake draft, so that equilibrium is re-established at a higher rate of heat input to the boiler.

Alternate Type of Metering Control

In an alternate to this hookup, as shown in Fig. 4, the "master" energizes the air-flow controller as above. The latter, in turn, repositions the uptake damper to give a predetermined draft loss and gas flow across the boiler. The resultant change in furnace draft is then corrected by the furnace-draft controller which adjusts the forced-draft fan damper, so completing the regulating cycle.

The foregoing indicates the various steps through which the several controllers move, with every change in load and steam pressure. Actually, the operation of the three controllers is smooth and practically simultaneous, so

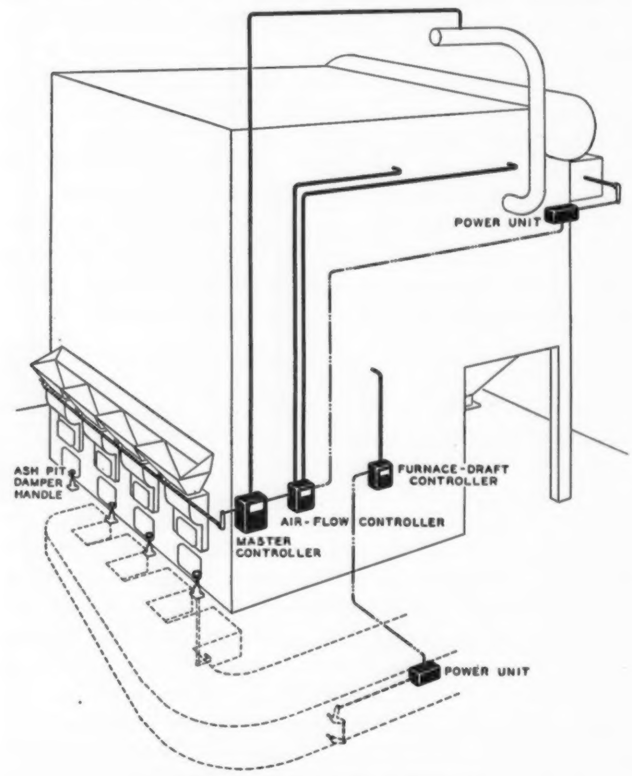


Fig. 4—Metering type control
Note that the "master" positions the fuel feed and air flow controller mechanism to meet load requirements, the air flow controller then adjusting the uptake draft and the furnace draft controller positioning the forced-draft damper to restore equilibrium

that equilibrium is restored almost instantly. The rapidity with which this balance is re-established is a measure of the performance of the combustion controllers, as any undue delay or hunting, is very detrimental to overall efficiency.

Desirable Instruments

Instruments are very desirable to facilitate adjustment of the controls, and the readjustment which is usually required when fuel or load conditions change materially. A furnace-draft indicator or recorder rates first place, followed by gages showing uptake draft and undergrate pressure, and means for showing the excess air, such as steam flow-air flow meters, CO_2 indicators or recorders, or smoke indicators. Temperature indicators or recorders, showing particularly exit temperatures, are also recommended. The operator who knows the steam output, boiler draft loss, excess air and exit temperature can judge very closely whether or not his equipment is operating at its highest efficiency. Most firemen, with proper instruction, soon get to know and use their instruments, to help them in securing better and easier operation. They quickly learn that a well controlled fire is a clean fire, and a clean fire is easy to handle.

Operating Procedure

Let us follow through the regular operating procedure and see how closely the automatic control fits into this schedule, when thoroughly understood and properly used.

When starting a new fire with kindlings across the front of the grate, a thin layer of coal, about 1 in. in thickness, is first spread over the entire grate, using the manual control to avoid overfeeding. This layer should not be too heavy as ignition is more rapid in a thin bed, and the probability of excessive smoke, when the coal starts burning, is reduced. The kindling is then ignited, and when burning actively a light feed is started, again using the manual control for coal and air. The latter should be kept at the minimum necessary to avoid smoke and chilling of the fuel bed and furnace, which tends to retard ignition.

An active coal fire is usually obtained in between ten and fifteen minutes, and in a number of cases, where the setting is already hot from previous operation, the boiler has been put on the line within fifteen minutes of lighting off.

As soon as the fuel bed is burning all over, coal and air are gradually increased, using the manual control, until the pressure rises to the point where the boiler is cut in on the line. At this point the control can be switched to automatic, and the coal-air ratios should be checked by observation of the fuel bed, CO_2 or smoke recorder, and necessary adjustments made.

As this initial fuel bed is likely to be somewhat irregular because of manual control of fuel and air, it is usually advisable to burn down and dump, within an hour or two, and start with a clean fire on automatic control. During this starting period, the speed of the distributor shaft should be adjusted to ensure a uniform fuel bed without overfeeding at the bridge wall, or a short fire. Heavy irregular fuel beds, clinkers and smoke, all indicate improper fuel-air proportioning or distribution.

Observation of the fuel bed and excess air under varying load conditions will show whether the coal-air ratios remain correct, and depending on the type of control, the required adjustment should be made. Such adjustments should be made by an experienced operator, and only one change should be made at a time, so that the effect of each may be observed.

As a general rule, the limit of capacity with a spreader stoker is reached when the available draft is insufficient to carry away the products of combustion, and maintain a reasonable furnace draft. The stoker frequently has several times the coal-feeding capacity required, depending on the quality of the fuel, and the forced-draft fans are usually selected with a considerable excess factor. When adjusting the controls it is important that

this be kept in mind, so that fuel and air supply are limited to carry the desired maximum load, or to the capacity of the draft available, whichever is reached first.

Suggestions to Be Followed During Cleaning Periods

With a little cooperation on the part of the fireman, the automatic control will do its share to hold the boiler pressure constant during cleaning periods. Most modern spreader stokers have the grate and ashpits divided into zones corresponding to the number of feeder units. Each of these zones has a hand-controlled damper used to shut off the forced draft while the grate above is being cleaned. When this damper is closed the air flow to the remaining sections of the grate is increased. The fireman then manually increases the coal feed to these active sections to balance this increased air supply, as discussed more fully below.

When the cleaning period arrives, the coal feed to one unit is discontinued without change in the automatic control. As soon as this fuel bed is burned down, usually in not over a minute's time, the ash-pit damper to this zone is closed, this being a manual operation. The increased flow of air to the remaining active zones permits increased coal feed, this being accomplished by manual adjustment of the handles on each unit. Should the steam pressure drop while the ashpit is being cleaned, the automatic control will increase the coal and air supplied to the active zones and, unless the load is abnormally heavy, little drop in pressure will usually be experienced.

Assuming that the normal combustion rate on the entire grate is 25 lb per sq ft per hr at the cleaning period, the rate on the active half of a two-section grate would be increased to 50 lb, for the few minutes required to clean the ashpit. For a three- or more unit stoker the load is more easily carried, and with several stokers on the line, the automatic control should make the necessary readjustment to carry the load, without troublesome drop in pressure.

The several sections of each stoker should be cleaned consecutively, and with as little delay as possible, so that the fuel beds on the various parts of the grate will be of similar thickness and resistance to air flow. It is obvious that a recently cleaned fire will have less resistance than one with a 4-in. ash bed, and uniform fuel-air ratios are impossible under such conditions.

The grate surface of the modern forced-draft spreader stoker is so designed that the resistance of the grate is from 50 to 75 per cent of the combined resistance of grate and fuel bed, the average air space being from 2 to 3 per cent. This helps materially in assuring uniform air flow through the various parts of the fuel bed. However, the automatic control must do its part in supplying the required quantity of air.

As soon as the grate has been returned to its operating position after dumping, the coal feed is restarted on the manual side, or at a reduced rate on the automatic, to avoid excessive feeding, which not only retards ignition but is likely to cause smoke when ignition takes place, as the ash-pit damper remains closed. Ignition usually takes place within a few seconds, or at most a minute, and as the fuel bed becomes fully ignited, the ash-pit damper is gradually opened. The coal feed should then be returned to the normal automatic position, with a quick restoration of any loss in steam pressure.

Ash Handling

Ash removal may be accomplished in any of several ways, depending on the type of ashpit, and ash removal equipment. The following procedures are normally recommended:

1. Shallow Ashpit and Wheelbarrow: Clean the ashpit while ignition is being established and the ash-pit damper is closed. Natural-draft air flow through the open ash-pit door will maintain a satisfactory fuel bed condition at reduced combustion rate. Ash removal may be accomplished by use of a scraper, but a long-handled scoop is usually preferred, as quicker and less laborious, the ash being placed directly in the wheelbarrow rather than first scraped out and then shoveled, which involves two operations.

2. Shallow or Deep Ashpit and Steam Jet or Scraper Conveyor: As it is desirable to operate such conveyors for as short a time as possible in order to conserve steam and power, and reduce maintenance, the fires should all be cleaned and dumped before starting the conveyors. Ash should then be removed from one pit at a time, by closing ash-pit dampers and reducing coal feed on this unit only, to that readily burned by natural draft, as the ash-pit doors are opened.

Automatic control aids greatly during the cleaning period, as the operators can concentrate on the job of getting the fires cleaned and the ashes removed in the shortest possible time, without having to take time out to watch the steam pressure.

Conclusions

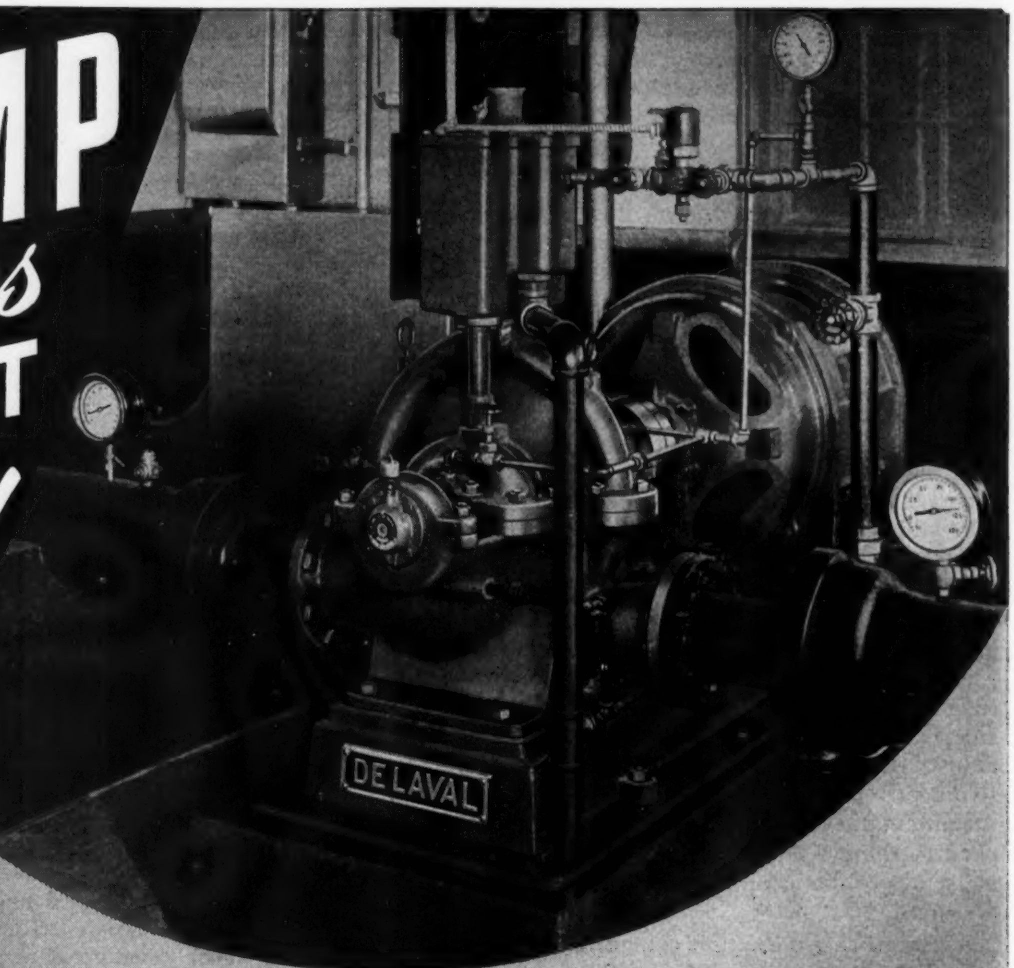
Spreader-stoker-fired boiler plants can be so satisfactory when well designed and operated, that every effort should be made by both designers and operators to secure the maximum benefits by full realization of the limitations and requirements of this type of stoker. Among the most important of these requirements are ample furnace and grate dimensions, cinder collection and disposal equipment and suitable and well-adjusted automatic control mechanism.

In addition to its ability to burn coals of widely varying characteristics, this type of stoker is applicable to all types of boilers and is capable of meeting rapid and large variations in load with satisfactory results when properly controlled.

Competent operation is fully as essential for satisfactory performance as properly designed and well-built equipment, and no job can be better than the men who run it. Automatic controls might better be termed mechanical controls, as they do no more than a first-class operator could do, if he were to give constant attention to the operation. However, in many boiler plants the operator's duties are such that he cannot give undivided attention to the fires; hence the application of automatic combustion control is most desirable, especially if the character of the load involves rapid changes.

The foregoing was prepared with a view to providing a better understanding of how automatic combustion control functions to assure maximum service from spreader stoker firing.

PUMP *comes* RIGHT *back!*



Pump fitted with De Laval submerged suction priming system; 1100 g.p.m. against 245 ft. at 1750 r.p.m.

If the three-quarter-inch corporation cock on the suction pipe of the pump illustrated above is opened wide, delivery of water ceases, but is resumed again within one minute after the cock is closed, the pump being at once reprimed by the

DE LAVAL *SUBMERGED SUCTION* PRIMING SYSTEM

Were the air inleakage too great for the priming system to handle, the pump would automatically be shut down and could not be started again until the fault had been corrected.

With the De Laval Priming System the pump cannot be started unprimed.

Danger of surges or water-hammer reaching the pump casing is eliminated or minimized.

The pumping unit can be started or stopped at any time, from a remote control point if desired.

Proper adjustment of packing glands is simplified, as pressure is not admitted to the pump casing and suction line.

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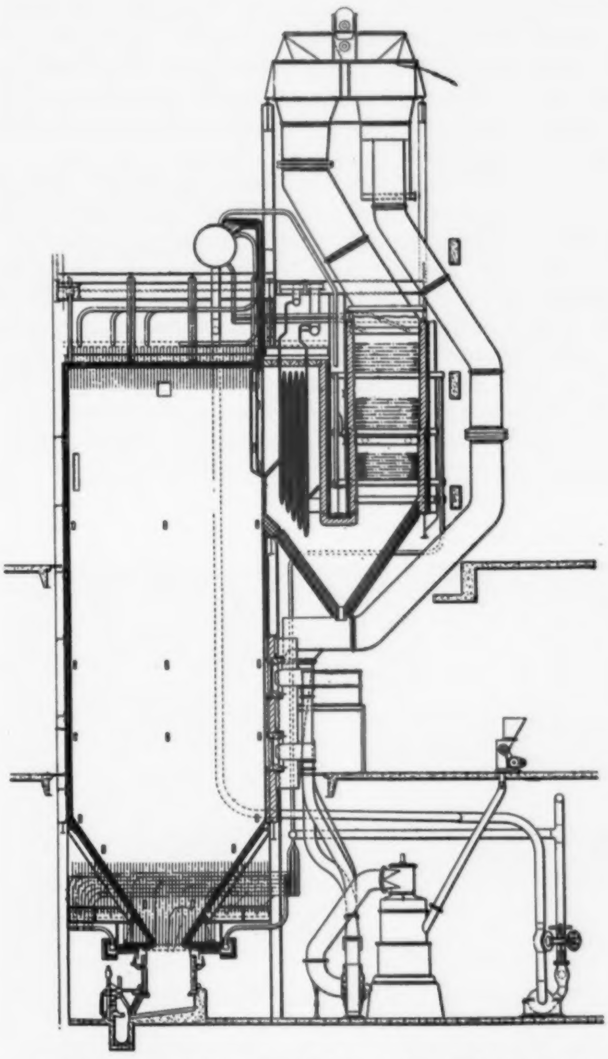
Forced-Circulation Unit for Rubber Plant

The accompanying cross-section represents a C-E controlled forced-circulation steam generating unit now under construction for one of the synthetic rubber plants. Rated at 350,000 lb per hr, it will furnish steam to a back-pressure turbine, the exhaust of which will be superheated and closely controlled in a separately fired superheater for process use.

The unit here shown is designed to burn eastern bituminous coal, pulverized in two Raymond bowl mills, and



Section through controlled forced-circulation unit for medium pressure and steam temperature

fired by four Type R horizontal turbulent-type burners in a dry-bottom furnace. It presents a simple and compact arrangement with trifurcated furnace walls absorbing all the radiant heat, the only convection boiler surface being secondary evaporating surface in the last pass following the superheater and immediately below the economizer. The superheater is of the Elesco pendant type and, after leaving the economizer, the gases will pass over a Ljungstrom regenerative-type air preheater in which the air for combustion will be raised to 390 F at full load.

Steam conditions at the superheater outlet will be 725 lb pressure and 700 F at rated capacity, with feedwater at 362 F.

There will be two turbine-driven circulating pumps connected between the downcomer pipe and the bottom header system. Distribution of water to the various circuits is by means of orifices inserted at the entrances to the individual furnace wall tubes.

This will be the second large controlled forced-circulation boiler to be installed in a stationary power plant in this country, the first of nearly twice the capacity and two and a half times the pressure, having been placed in operation in one of the large utility plants last summer. It is described elsewhere in this issue.

Midwest Power Conference

Feeling that such a conference can be a stimulus to the war effort through the presentation of papers aimed at meeting some of the present power and fuel-burning problems, it has been decided to hold a 1943 Midwest Power Conference. Headquarters, as in the past, will be at the Palmer House, Chicago, and the dates selected are April 8 and 9. The Committee hopes soon to be able to announce the tentative program which is being selected with special reference to giving helpful suggestions on present needs of the field.

(*Continued from page 31*)

Tests on Steam Pipe Insulation

This paper by E. A. Allcut, Professor of Mechanical Engineering, University of Toronto, presented an investigation of heat losses through cylindrical samples such as pipe coverings composed of magnesia, spun rock wool, glass wool and corrugated asbestos. The effect of metallic, fabric and paint covering was also investigated. The results of the tests made were plotted on seventeen charts and seven tables were also included in the paper.

The tests were made on 3-ft pipe lengths of 2 in. and 8 in. diameter using pipe coverings as indicated above of various thicknesses, and temperatures were electrically recorded. In interpreting the data furnished by the tests Professor Allcut offered the following conclusions:

1. Short lengths of pipe insulation may be tested by the electrical method and will give results that are comparable with those obtained by other methods.

2. The results obtained on similar insulating materials when applied to pipes of 8 in. and 2 in. diameter, respectively, agree within practical limits.

3. At pipe temperatures below 500 F the conductivity of spun rock wool is slightly below that of 85 per cent magnesia pipe insulation. Between 500 and 600 F there is little difference between the two materials.

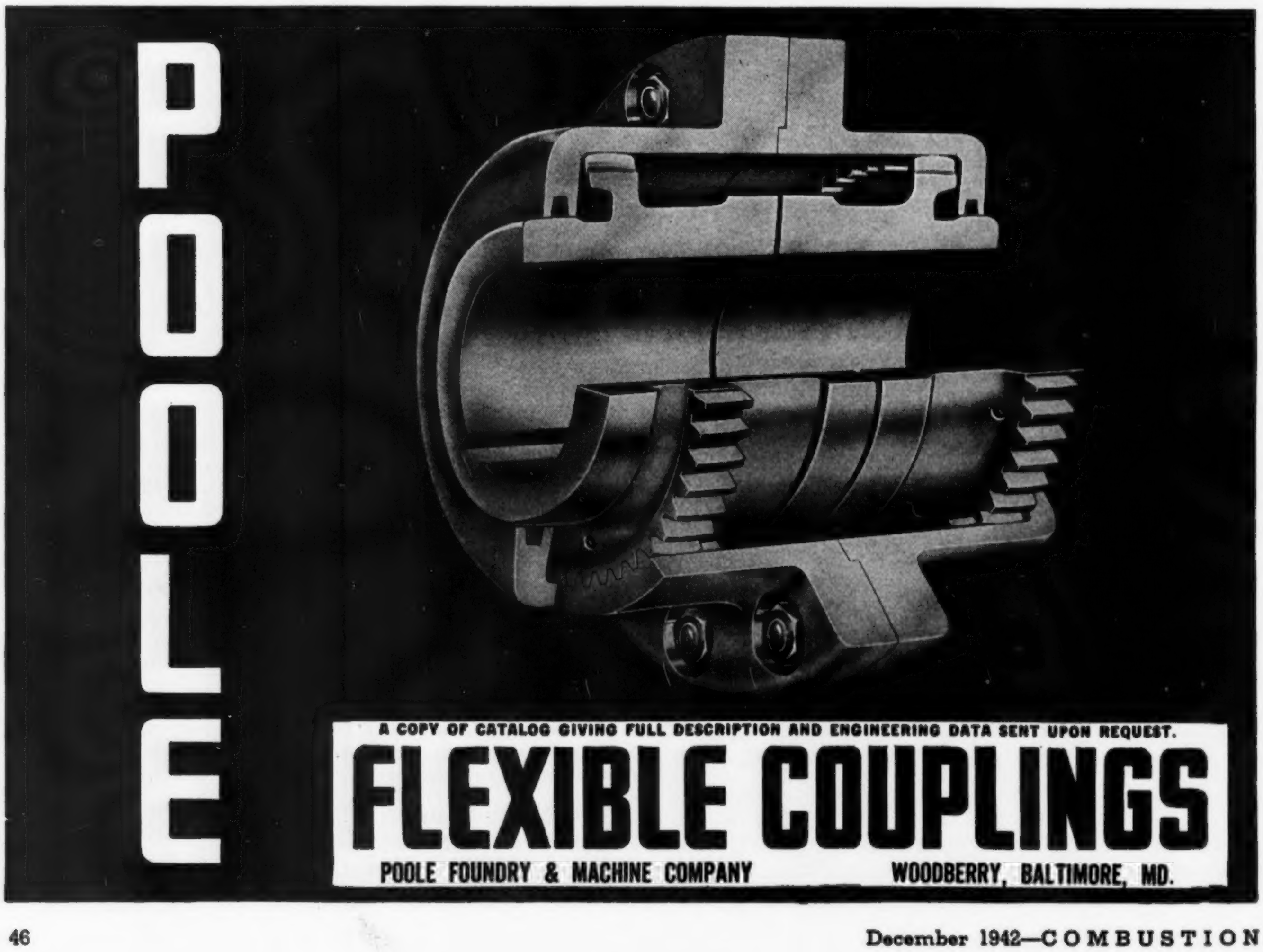
4. Variations in density, produced by different proportions of silicate binder, have little influence on the conductivity of spun rock wool. The conductivity also appears to be practically independent of variations in thickness of material. These remarks refer only to the range of the present series of tests.

5. Exposure to winds of 15 to 20 miles per hour gives increased heat losses up to 16 per cent, as compared with natural convection. This increase is small for pipe insulation more than $1^1/_2$ in. thick, but appears to be greater with metallic coverings than it is with fabric.

6. In still air, the surface temperature of metallic coverings is greater than that of fabric coverings. This counteracts the lower emissivity of the metal so that there is little, if any, saving of heat if metallic outer coverings are used.

7. Painting the outer surfaces of canvas coverings with a single coat may increase the heat loss substantially as compared with unpainted surfaces. This includes aluminum paint with a turpentine base. If a sufficient number of coats are applied to give complete surface protection, the use of paint does not appear to affect the heat losses materially.

During the discussion the point was raised that no mention was made of an overall heat balance and that further investigation and analyses were required. The question as to how the data furnished checked with the results of calculation was also raised. In reply Professor Allcut agreed that further investigation was desirable and that his paper was more in the nature of a progress report rather than the result of a complete investigation. Unfortunately limitation of time, due to the present emergency, made it necessary to postpone a check by calculation until a more convenient season.



The Spirit of the People

"The unity of the American people and of the variety of races composing it prove their confidence in the outcome of the war and a determination to play their part in the post-war world," declared James W. Parker, President of the American Society of Mechanical Engineers, in his address at the recent annual banquet of the Society.

Non-Political Leadership Needed

"People believe they shall be facing a trial of their faith in self-government and for that matter a test of their beliefs regarding the very fundamentals of national life," said Mr. Parker. "They are getting a better conception of their duty to choose men of intellectual and moral capacity, and we can no longer afford to delegate leadership to professionalized politicians and economists."

The visits which he, as President of the Society, had made in the last twelve months to local sections and student branches in twenty-nine states and in provinces of Canada, had afforded an opportunity of seeing much of the industrial effort being put forth by the people in wartime and of observing the attitudes of mind of members of the Society throughout the country. Of this he said:

"It is not surprising to find that men everywhere are in a thoughtful mood. This is true not only of the mature members, many of whom are actively engaged in adapting industrial production to the requirements of the war; but it is true also of the younger men in the student branches. Most of these expect shortly to enter military service, but they are puzzled to know whether or not they will be given an opportunity to make use of the engineering training or will be able to resume that training after the war."

He was struck more than ever before with the variety of races which have gone to make up the American people and with the wealth of talent and energy these differing races have contributed. Despite diverse origins, the American people are exhibiting a remarkable degree of homogeneity of thought and intent regarding national affairs. The singleness of purpose with which all hands are devoting their energies to the supplying of the armed forces with needed equipment and supplies was manifest on every hand. And one notices an absence of rancor withal, as of an older people who have attained tolerance with their maturity. It is the unmistakable indication of their ultimate confidence in the successful outcome of the world conflict.

Engineers Looking Ahead

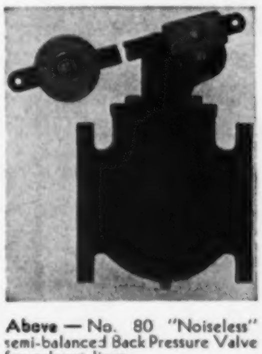
"In spite of their preoccupation with the demands imposed by immediate tasks, members of the Society," said Mr. Parker, "are devoting much thought to the future. The admonition of Past President Batt in his notable address to the Society in 1940, that engineers give heed to the changes that will inevitably be upon us after the war, has given the impetus to some of this thinking. They are aware that the productive capacity of industry is being greatly enhanced, and while there can be no doubt that the genius that made possible such a rapid conversion of product to the purposes of war will find means for shifting industry back to things needful in peacetime, engineers are nevertheless giving consideration to the kind of world economy we shall be living under. It is significant that so many of our profession are turning their thoughts in that direction. It is one of the hopeful signs of the

Automatic RELIEF VALVES *for* Every Job

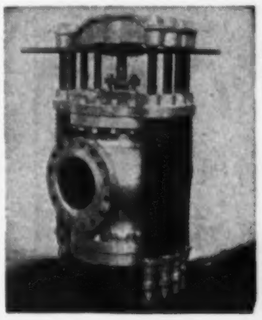
PRESSURE RELIEF • VACUUM RELIEF
ATMOSPHERIC RELIEF • PUMP BYPASS

THE DAVIS LINE (Standard Items)	For Steam, Air and Gas *Also Water and Oil												For Steam									
Valve No.	13R*	14R*	15R	16R*	18R*	19R*	49	180R*	182R*	260	261*	401	80	81	82	110 118	111 112	113	113B	116 117	110B	265
Service: Pressure Relief to Atmosphere												✓	✓	✓	✓				✓		✓	
Service: Pressure Relief into L. P. Lines		✓	✓	✓																		
Service: Vacuum Relief		✓	✓	✓	✓	✓																
Service: Pump By-Pass	✓							✓														
Service: Protection of Major Equipment										✓	✓					✓	✓	✓	✓	✓	✓	✓
Max. Relief Pressure	100	150	30	125	50	100	200	150	500	50	15	500	20	20	20	Atmos.	Atmos.	Atmos.	10	Atmos.	10	250
Single Seat	✓				✓	✓	✓			✓	✓					✓	✓	✓	✓	✓	✓	✓
Double Seat		✓	✓	✓			✓	✓	✓			✓	✓	✓	✓							
Diaphragm Actuated	✓	✓	✓	✓	✓	✓		✓														
Piston Actuated									✓													
Direct Disc Actuated										✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Auxiliary Pilot Control							✓					✓										
Spring Loaded	✓	✓				✓	✓	✓	✓	✓	✓	✓										✓
Weight Loaded			✓	✓	✓								✓	✓	✓				✓		✓	
Range of Sizes, Scr'd.	3/8"-2"	1/2"-4"	1/2"-4"	1/2"-4"	1/2"-4"	1/2"-4"	1/2"-4"	1/2"-4"	1/2"-4"	2"-4"	2"-4"	1/2"-4"	2"-6"	2"-6"	2"-6"							
Range of Sizes, Flg'd.		1 1/2"-14"	1 1/2"-14"	1 1/2"-14"	1 1/2"-14"	1 1/2"-14"	1 1/2"-14"	1 1/2"-4"	1 1/2"-4"	2"-8"	2"-8"	1 1/2"-14"	2"-24"	2"-24"	2"-24"	6"-30"	6"-48"	6"-30"	6"-30"	6"-30"	6"-30"	4"-20"
Material Specifications, Body: Bronze	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓										
Material Specifications, Body: Semi-Steel	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Material Specifications, Body: Steel	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓										✓
Material Specifications, Trim: Bronze	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Material Specifications, Trim: Nickel Iron		✓		✓			✓					✓										
Material Specifications, Trim: Monel	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓										✓
Material Specifications, Trim: Stainless Steel	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓										✓

USE the check list above to determine the proper type of relief valve for your job. It lists valves suitable for every relief service, including valves designed for full pipe capacity at rated relief pressure with minimum accumulation. Hand testing levers may be incorporated on most designs. Manual control and stay-open features are available on atmospheric relief valves. Send data on your service conditions for complete recommendations on the proper valves for your plant. DAVIS REGULATOR CO., 2510 S. Washtenaw Ave., Chicago, Ill.



Above — No. 80 "Noiseless" semi-balanced Back Pressure Valve for exhaust lines.



Left — No. 265 Turbine Bleeder and High Pressure Relief Valve.

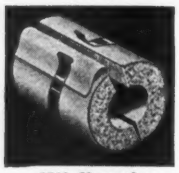
Right — No. 110 Exhaust Relief Valve for condenser protection service.

DAVIS VALVES

DAVIS REGULATOR CO.

Carey HEAT INSULATIONS

Careycel Insulations
For temperatures up to 300° F.



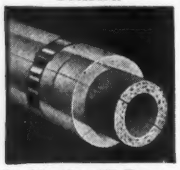
85% Magnesia
For High and Medium Pressure.

Cut Production Costs

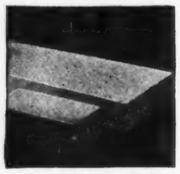
Many industrial plants are saving thousands of fuel dollars each year through the correct application of CAREY Heat Insulations . . . a complete line of high efficiency insulating materials of Asbestos and Magnesia for every known service condition—for temperatures ranging from

SUB-ZERO to 2500° F.

Put your special problems up to Carey Engineers . . . their experience and Carey research facilities are available through branch offices covering the nation. Write for book of interesting, technical data. **Address Dept. 69.**



Combination Hi-Temp—85% Magnesia.

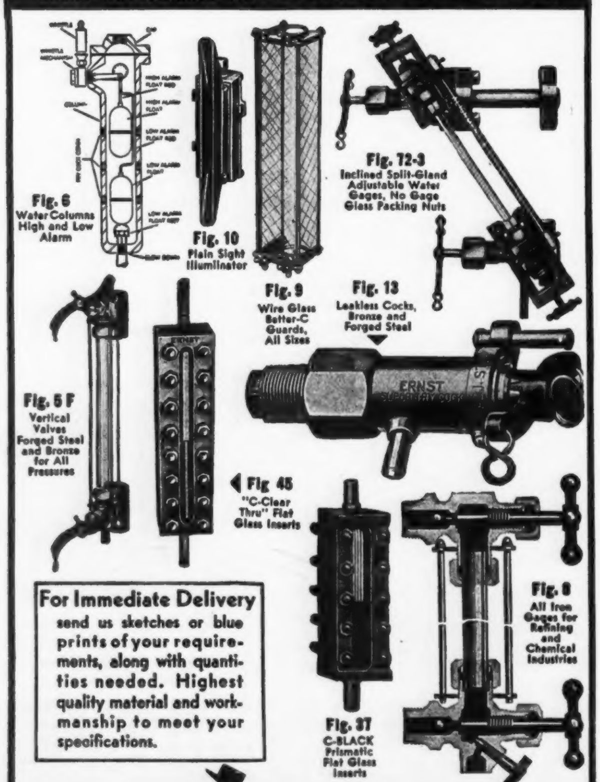


Hi-Temp Blocks—For Furnaces, Ovens, Kilns, etc.

Hair Felt Insulation
For sub-zero.

THE PHILIP CAREY MFG. COMPANY
Dependable Products Since 1873 Lockland, CINCINNATI, OHIO
In Canada: The Philip Carey Co., Ltd. Office and Factory: Lennoxville, P.Q.

Safer Boiler Operation Easier Maintenance with ERNST FITTINGS



ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, N. J. Phone: Livingston 6-0276

times. People believe they shall be facing a trial of their faith in self-government and for that matter shall be facing a test of their beliefs regarding the very fundamentals of national life.

"With a clearer perception of the responsibilities laid upon the nation's leaders in this time of great crisis has come a better conception of the people's duty to choose men of great intellectual and moral capacity," said Mr. Parker. "There is no lack of reference now for the memory of Washington, Grant and Lincoln, and the other great statesmen of the nation's past; but we begin to see that even these men only reflected the will and stamina of the people themselves. It is by the decisions of the whole people that the nation's courses are determined. Some of these decisions are made instinctively and some are the results of wise leadership. We can no longer afford to delegate that leadership to our professionalized politicians and economists.

"Engineers are asking themselves whose duty it is to combat false doctrines; and to that question there can be only one answer. The conclusion is inescapable, that the people of America are being amalgamated by the pressure of great events.

EQUIPMENT SALES

as reported by equipment manufacturers to the Department of Commerce, Bureau of the Census

Boiler Sales
Stationary Power Boilers

	1942 Water Tube		1941 Water Tube		1942 Fire Tube		1941 Fire Tube	
	No.	Sq Ft*	No.	Sq Ft*	No.	Sq Ft	No.	Sq Ft
Jan.	202	1,637,588	170	968,275	53	61,990	89	123,459
Feb.	238	1,557,004	97	847,331	59	84,660	81	104,622
Mar.	273	1,520,654	138	988,037	166	92,999	86	89,324
Apr.	430	2,441,668	159	802,993	57	81,402	129	151,636
May	160	1,280,558	134	850,659	63	90,069	114	154,964
June	139	847,562	141	743,762	61	75,831	114	134,880
July	134	891,224	184	1,184,984	48	56,996	94	121,884
Aug.	114	‡936,660	113	749,405	26	30,228	51	101,284
Sept.	48	378,096	120	843,896	337	275,808	61	63,385
Oct.	153	1,052,917	140	835,912	14	24,611	89	96,740
Jan.-Oct. Incl.	1,891	12,543,931	1,396	8,815,254	884	874,594	908	1,142,178

* Includes water wall heating surface.

Total steam generating capacity of water tube boilers sold in the period January to October (incl.) 1942, 106,825,000 lb per hr; in 1941, 89,394,000 lb per hr.

†Mechanical Stoker Sales

	1942 Water Tube		1941 Water Tube		1942 Fire Tube		1941 Fire Tube	
	No.	Hp	No.	Hp	No.	Hp	No.	Hp
Jan.	87	42,876	77	41,975	154	23,550	94	14,036
Feb.	131	55,001	60	27,736	185	26,889	117	14,774
Mar.	84	46,055	69	31,342	212	31,715	146	21,552
Apr.	102	49,061	75	34,832	313	39,877	147	20,555
May	125	44,069	90	43,971	206	33,566	144	19,267
June	123	48,267	136	50,896	296	49,760	264	42,619
July	131	59,376	113	50,108	297	45,902	290	40,943
Aug.	94	40,619	96	41,882	295	49,725	391	49,547
Sept.	78	37,081	83	33,663	295	44,910	335	49,559
Oct.	85	26,633	57	21,269	353	49,575	344	54,027
Jan.-Oct. Incl.	1,040	449,038	856	377,674	2,609	395,469	2,272	326,879

† Capacity over 300 lb of coal per hr.

Pulverizer Sales

	1942 Water Tube			1941 Water Tube			1942 Fire Tube			1941 Fire Tube		
	No. (N)	No. (E)	Lb Coal/hr	No. (N)	No. (E)	Lb Coal/hr	No. (N)	No. (E)	Lb Coal/hr	No. (N)	No. (E)	Lb Coal/hr
Jan.	102	3	1,071,340	39	—	462,990	—	—	—	—	1	1,000
Feb.	21	1	246,520	42	4	734,200	—	—	—	—	—	—
Mar.	31	7	360,620	31	3	739,700	1	—	13,300	—	—	—
Apr.	49	8	845,740	14	8	225,740	—	—	—	1	—	2,800
May	26	4	373,962	54	10	777,320	—	—	—	—	4	7,000
June	24	3	323,500	28	24	523,540	—	—	—	—	1	1,000
July	21	11	300,880	57	7	828,640	—	—	—	—	1	600
Aug.	3	12	180,460	30	5	456,480	—	—	—	—	1	800
Sept.	*23	12	*488,900	38	2	480,030	—	1	700	—	—	—
Oct.	48	3	961,870	59	—	764,620	—	—	—	—	—	—
Jan.-Oct. Incl.	348	64	5,153,792	392	63	5,993,260	1	1	14,000	1	8	13,200

(N)—New Boilers; (E) Existing Boilers. * Revised.

NEW CATALOGS AND BULLETINS

Any of these publications will be sent on request

Automatic Steam Generators

Super Mold Corporation of California has issued an 8-page bulletin (No. 222A) describing the Lodi Steam Generator which is a small flash-type boiler unit equipped either for gas or oil firing. The unit operates on the forced circulation principle with an automatic jet control system regulating the admission of feedwater in direct proportion to the amount of steam passing the throttle valve without the aid of thermostats or motor-driven pumps. Small size units have a heating surface of 28, 45 and 66 sq ft. Illustrations include an assembly view and a diagram showing the principles of operation.

Cable Saving Calculator

A handy calculator (designated GES-3043) that works like a slide-rule has been prepared by the General Electric Company to show at a glance how much copper can be saved in a war-plant electric power system by installing unit substations at the centers of the load areas. The reverse side of the rule carries a chart showing the per cent increase in cable copper as the voltage is decreased, and another chart giving the cable copper needed to carry a 1000-kva load at various voltages over distances from 10 to 1000 ft.

Centrifugal Compressors

The B. F. Sturtevant Company has just issued a 20-page catalog (No. 386-2) covering its line of Design 9 centrifugal compressors which are available in more than 200 sizes, with pressures from $^1/_2$ to 3 lb, for volumes up to 5500 cfm. This attractive bulletin is devoted to descriptive data, performance tables, dimension diagrams, etc., and includes many unit and installation photographs in halftone, also a full page cross-sectional view of a centrifugal compressor.

Specific Heats of Gases

"The Specific Heats of Certain Gases Over Wide Ranges of Pressures and Temperatures" is the title of Bulletin No. 30, a recent publication of the Cornell University Engineering Experiment Station. The gases are air, carbon dioxide, carbon monoxide, ethylene, hydrogen, methane, nitrogen and oxygen; the temperature range is from 0 to 4000 F; and the pressure range is from 0 to 10,000 lb per sq in.

This bulletin gives the general equations which determine the effect of pressure on the specific heats of the gases within ranges of temperature and pressure encountered most frequently in engineering practice. For the gases considered in this paper, the variations of specific heats with temperature and pressure are also shown graphically.

Single copies of this bulletin may be secured without charge by writing to the Engineering Experiment Station, Cornell University, Ithaca, N. Y. The price for additional copies sent to the same person is 50¢.

Frequency Recorders

Micromax frequency recorders and indicators are described in a 20-page catalog (N-57-161) issued by Leeds & Northrup Company. The booklet contains many halftone illustrations of automatic and manually operated instruments, mechanisms, panel mountings, circular and strip-chart models (in color) and includes a description of the impedance bridge circuit used in these Micromax instruments.

Motor Finder

The Allis-Chalmers Manufacturing Company offers a new "Motor Finder" as an aid to motor users in selecting various types of squirrel-cage motors. With the "Motor Finder," the motor user is able to match conditions under which the motor must operate at the proposed installation with the required motor characteristics and instantly learn the right motor type and its features. Over thirty standard types, conforming to WPB recommendations and covering a range from $^1/_2$ to 75 hp, are included in Allis-Chalmers Lo-Maintenance line and all the characteristics of versatility of squirrel-cage motors are considered in using the motor finder.

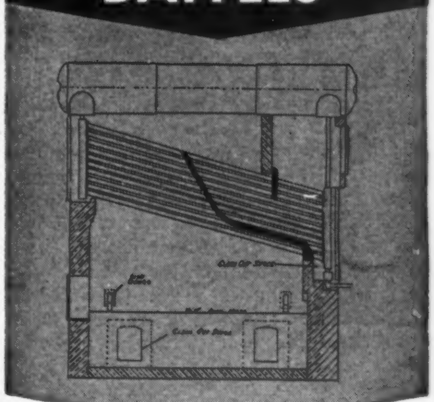
Refractories

Data on the handling, storage and use of firebrick and refractory specialties as applied to U. S. Maritime Commission Vessels, Design EC-2, is given in a 16-page refractory handbook issued by the A. P. Green Fire Brick Company. A listing of refractory materials required per ship (2 boilers) is given together with sectional views showing the assembly arrangement. Many halftone illustrations accompany the text which fully describes the handling and application of these refractories.

Water Filters

Graver water filters and accessories are described in a 12-page bulletin (Form 313) recently received from the Graver Tank and Manufacturing Company. This catalog pertains to pressure-type water filters and inlcudes specifications for single units of both vertical and horizontal designs. The bulletin is illustrated with many halftones showing cut-away views and multiple-unit installations.

ANY type of boiler will deliver MORE POWER at LESS COST with Enco Streamlined BAFFLES

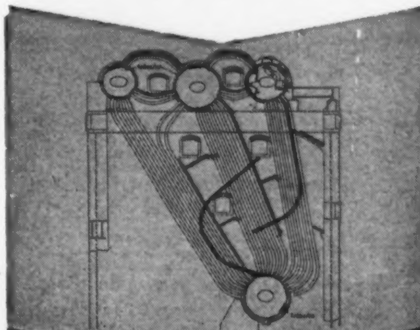


THE cross-flow principle of Enco Streamlined Baffles with its higher efficiencies, may be applied to any type of boiler — horizontal or vertical, straight or bent tube.

By streamlining and curving, gas passages are tapered to maintain velocity as the gas volume is reduced, resulting in a higher rate of heat transfer to boiler and superheater surfaces, and lower flue gas temperatures.

Enco Streamlined Baffles reduce draft loss by eliminating eddy currents, bottlenecks and dead gas pockets—save steam because soot blowers work less often and more effectively.

Ask for Bulletin BW-40 containing valuable engineering data on modern baffle wall construction—It's free.



THE ENGINEER CO.

Enco 75 West St. New York, N. Y.

Pricing of Used Equipment

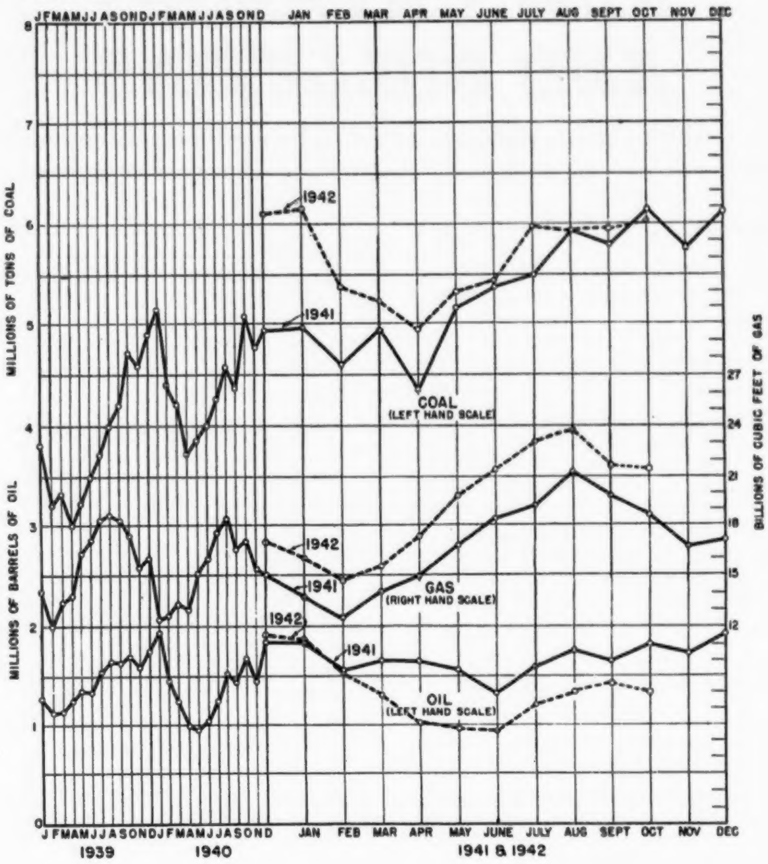
Changes in OPA regulations designed to simplify the calculation of maximum prices for used equipment and parts were announced on November 21.

In calculating the price of a used machine or part, the seller shall first ascertain the maximum price f.o.b. factory of the nearest equivalent new machine. If the used equipment is sold as "rebuilt and guaranteed," or if it has been so little used as to be equivalent to rebuilt equipment, the maximum price f.o.b. shall be 85 per cent of that of the new machine or part; or if sold on an "as is" basis, a maximum price of 55 per cent is prescribed. Previously, by interpretation, the maximum price of the used equipment was based on the delivered price of new equipment in the area of sale.

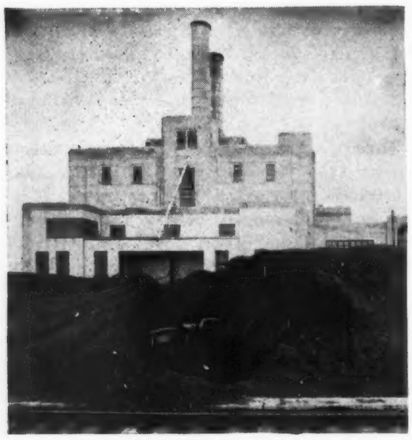
Also, if any sale is made on a "where is—as is" basis, the buyer shall be reimbursed for the cost of dismantling and unloading. An exception is made, however, where the cost of dismantling and loading is more than 10 per cent of the "as is" maximum price, as in the case of heavy equipment such as traveling cranes, tanks, boilers, etc. Here the seller is required to reimburse the buyer only to the extent of 10 per cent of the "as is" maximum price.

Where the equipment, machine or part is such that the manufacturer has no published or confidential price list, actual prices may be used. October 1, 1941 is fixed as the base pricing date for industrial heat-exchange equipment, open and pressure tanks or vessels.

CONSUMPTION OF FUEL FOR PRODUCTION OF ELECTRIC ENERGY



INCREASE YOUR COAL STORAGE



Above picture shows a Sauerman Scraper reclaiming coal from a 30,000-ton pile that it built on a limited ground space at a power plant. From a station overlooking the storage area the operator controls every move of the scraper through a set of automatic controls.

WRITE TODAY

for SAUERMAN catalog which gives details on equipment layouts for coal storage projects of every size.

with the aid of a SAUERMAN SCRAPER

If you need additional storage facilities to insure your plant against possible coal shortage during the winter, why not do as so many boiler plants in the defense industries have done—install a Sauerman Power Drag Scraper.

With a Sauerman scraper you can store more coal safely in a given space and the entire cost will be only a couple of cents per ton stored and reclaimed.

A Sauerman scraper layers the coal into the pile, avoiding segregation, and in this manner a high pile is built that is completely homogeneous. Chances for deterioration and spontaneous combustion are reduced to a minimum.

There is a size and type of Sauerman machine for every coal storage project, large or small.

SAUERMAN BROS., Inc.

550 S. Clinton St. Chicago, Illinois

Obituaries

L. W. Morrow, for a number of years editor of *Electrical World* and more recently professor of engineering administration at Rutgers University, died of a heart ailment at New Brunswick, N. J., on November 15. He was 54 years old.

Following graduation from Cornell University in 1911, Mr. Morrow taught electrical engineering for several years at the University of Oklahoma and later at Yale, joining the McGraw-Hill Publishing Company in 1921. He was widely known in the electric utility field.

David W. Haering, President of D. W. Haering & Co., water consultants of Chicago, died suddenly of pneumonia on October 30 at the age of 34. A graduate of the University of Illinois, Mr. Haering developed his company through the depression from a one-man organization into a corporation with an extensive research laboratory and technical offices in many of the large industrial cities. Scale and corrosion control were his specialties.

Bennett B. Bristol, who with his brother, Edgar H. Bristol, founded the Industrial Instrument Company in 1908, which later became The Foxboro Company, died at Falmouth Heights, Mass., on November 10 following a heart attack. He was 74 years old.

Joseph F. Porter, Chairman of the Board of the Kansas City Power & Light Company and President of that company from 1917 to 1938, died in Kansas City on November 7, in his eightieth year.

Research Projects at Battelle

Bituminous Coal Research, Inc., the research agency of the National Coal Association and the bituminous coal industry, has completed contract arrangements with Battelle Memorial Institute, Columbus, Ohio, for the largest coal research program ever undertaken by the coal industry. The contract calls for emphasis on the power and fuel problems of war industries and for the expansion and extension of earlier research studies. There will be extended investigations in the application of coal to metallurgical processes and of means of conserving coal by more efficient utilization in industrial and domestic power and heating plants.

In addition to conducting the research program, Bituminous Coal Research and its technical committee of fuel engineers are serving as consultant to the Government's Solid Fuel Coordinator, Petroleum Coordinator and the Power Branch of the War Production Board. Its services are being utilized for advisory work relating to the conversion of steam plants from other fuels to coal, as well as to assist in the selection of the available coal and proper burning equipment for new plants which will be built by the Government or by industries under WPB permission.

Among the research projects to be undertaken are use of pulverized coal in forge furnaces, more economical gasification of coal, smokeless methods of coal combustion, chemical dust-proofing of coal to replace the present oil-treatment methods, the development of power directly from coal by the use of pulverized coal as a fuel in an internal combustion engine and an investigation of possible new designs in coal-burning railroad locomotives. The research program is under the direct supervision of Ralph A. Sherman of the Institute's staff.

Ban on Over-Motoring

A purchaser of an electric motor must show that the horsepower of the motor he is applying for is no greater than that required to do the job, according to a provision in General Conservation Order L-221, announced by WPB.

Officials of the General Industrial Equipment Division pointed out that it has long been the practice of industry to apply greater motor capacity than necessary for the job to be done. As a means of stopping this practice, the order applies certain measurements by which the actual power requirements may be related to the horsepower of the motor applied for by the purchaser.

The order prohibits the delivery or acceptance of motors, unless they comply with certain standard specifications and are of the simplest practicable, mechanical and electrical design. It also requires the purchaser to certify and show reason why he must have a motor of a special type; and it restricts the use of such special types to the conditions and the purposes for which they are required.

One of the important conservation provisions in the order applies to both motors and generators. It requires the applicant to certify that he has made every reasonable effort (1) to adapt idle motors or generators in his possession, (2) to obtain used ones for his purpose and (3) to repair or recondition his existing equipment.

Where used equipment cannot be secured within a reasonable time by the applicant, it is suggested that he make his needs known to WPB's Surplus Used Equipment Branch, which will assist him in meeting them.

It is estimated that the conservation and simplification provisions in the order will save in one year about 15,000,000 lb of copper, 55,000 tons of carbon steel and 150,000 lb of stainless steel.

The order became effective December 10, 1942.

"Coal Adequate," says Ickes

Secretary Ickes, speaking as Coordinator of both solid fuels and petroleum, says:

"Reports have reached my office that representations have been made in some places that there would not be adequate coal for conversions. Such claims are being circulated apparently to dissuade conversions and are not based on facts. Adequate coal for all essential needs can and must be supplied. If consumers will order their coal well ahead of their actual needs, they will have an excellent opportunity to get it, since this will enable the mining and transportation industries to plan their operations so as to make continuous full use of manpower and equipment."

TVA Priority Ratings Revoked

The War Production Board has revoked priority ratings previously granted to the Tennessee Valley Authority for the construction and installation of five power-generating units at three locations having a total capacity of 190,700 kw. The units had been scheduled for completion in 1944. The stoppage was in line with WPB's policy of curtailing the flow of critical materials to construction projects. TVA projects ordered stopped were:

1. Hydro generating units Nos. 3, 4 and 5, each with a capacity of 32,000 kw, at Kentucky Dam on the Tennessee River near Paducah, Ky.
2. Steam-turbine generating unit No. 4 of 60,000-kw capacity at the Watts Bar steam plant in East Tennessee. Units Nos. 1 and 2 are already in operation and No. 3 is scheduled for completion in 1943.
3. Hydro generating unit No. 3 of 66,700-kw capacity at the Fontana Dam on the Little Tennessee River in North Carolina.

Oil From Coal

In his paper on "Analysis and Testing of Coal in Relation to Its Properties and Utilization" presented on October 13 before the Institute of Fuel, London, as recipient of the Melchett Medal, **Arno C. Fieldner** of the U. S. Bureau of Mines, included a table showing estimated yields of oil from a number of American coals. These estimates were based upon a correlation of the results of tests at the Bureau of Mines experimental plant and small autoclave tests with petrographic and chemical analyses.

The liquid-phase oil yield, in gallons per short ton of coal as mined, bore a direct relation to the coal rank. It ranged from a low of 55 gal in the case of Washington brown coal, 83 gal for North Dakota lignite, 140 to 150 gal for Mid-western coals, to a maximum of 166–168 for certain Pennsylvania and Alabama coals. Gasoline yields, assuming 70 per cent conversion, ranged from 42 to 136 gal per ton.

Awards

The first U. S. Maritime "M" Pennant in the fireclay field was awarded to the A. P. Green Fire Brick Company of Mexico, Mo., on November 10, together with Merit Insignias to 1475 employees of that company. The presentation was made by Col. W. F. Rockwell, Director of Production for the Maritime Commission.

The Army-Navy "E" has been awarded to the Union Asbestos & Rubber Company's Paterson, N. J., plant which is supplying heat insulations and packings for marine aviation and industrial use. At the ceremony the Navy was represented by Lt. Comm. S. J. Singer.

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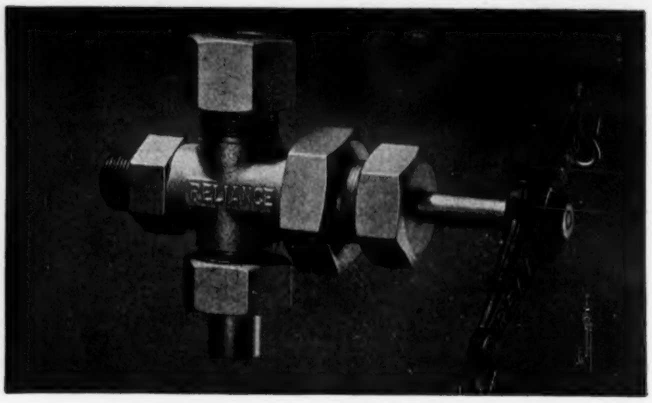

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